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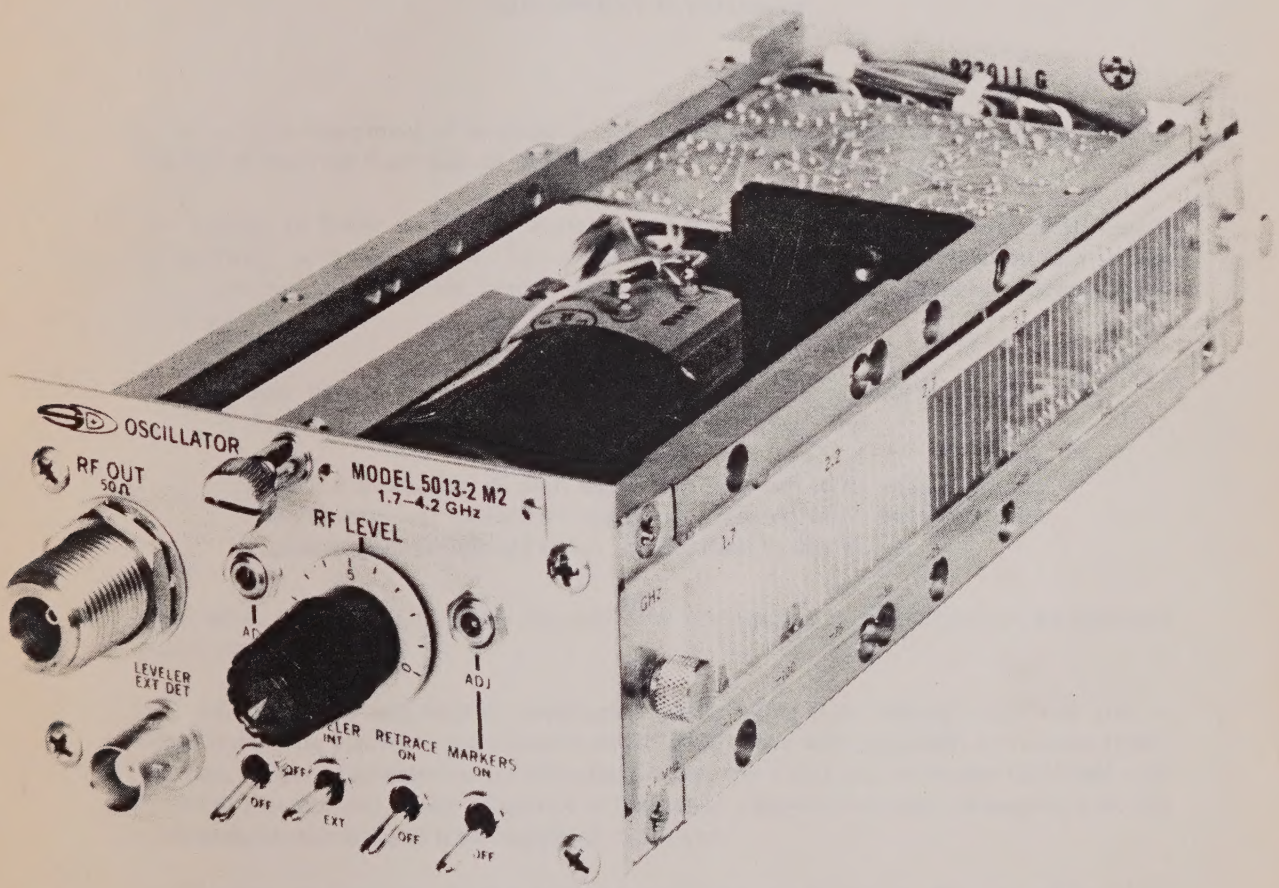
SYSTRON DONNER

OPERATION AND SERVICE MANUAL



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ONE SYSTRON DRIVE
CONCORD, CALIFORNIA 94518 USA

RF PLUG-IN UNIT

MODEL 5013-2

1.7 TO 4.2 GHz

MICROWAVE DIVISION
SYSTRON DONNER CORPORATION
TEST AND MEASUREMENT GROUP

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PAGE	CHANGE
Title	Original
i	Original
ii	Original
iii	Original
iv	Original
v	Original
vi	Original
vii	Original
viii	Original
1-1 through 1-7	Original
1-8	Blank
2-1 through 2-4	Original
3-1 through 3-9	Original
3-10	Blank
4-1 through 4-44	Original
5-1 through 5-7	Original
5-8	Blank
5-9	Original
5-10	Blank
5-11	Original
5-12	Blank
6-1 through 6-5	Original
6-6	Blank
7-1 through 7-7	Original
7-8	Blank
7-9	Original
7-10	Blank
8-1 through 8-3	2-2-81
8-4	Blank
8-5 through 8-9	2-2-81
8-10	Blank
8-11	2-2-81
8-12	Blank
8-13	2-2-81
8-14	Blank
8-15	2-2-81
8-16	Blank
8-17 through 8-19	2-2-81
8-20	Blank
9-1 through 9-3	2-2-81
9-4	Blank
9-5 through 9-7	2-2-81
9-8	Blank
9-9	2-2-81
9-10	Blank
9-11	2-2-81
9-12	Blank
9-13	2-2-81
9-14	Blank
9-15	2-2-81
9-16	Blank
9-17 through 9-19	2-2-81
9-20	Blank
9-21	2-2-81
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TABLE OF CONTENTS

SECTION/ PARAGRAPH	TITLE	PAGE
SECTION I	GENERAL INFORMATION	1-1
1-1.	SCOPE	1-1
1-2.	DESCRIPTION OF EQUIPMENT	1-2
1-3.	CAPABILITIES AND PERFORMANCE	1-2
1-3.1	External Power Requirements	1-2
1-3.2	Frequency Range	1-2
1-3.3	Mainframes	1-2
1-3.4	Leveling and Amplitude Control	1-3
1-3.5	Frequency Modulation	1-3
1-3.6	Optional Configurations	1-3
1-3.6.1	Option M2 Internal Leveling	1-3
1-3.6.2	Option M3 Fast Amplitude Modulation	1-3
1-3.6.3	Option M3A Fast Amplitude Modulation	1-3
1-3.6.4	Option M6 Wide Deviation Phase Lock	1-3
1-3.6.5	Option M7 Power Meter Leveling	1-4
1-3.6.6	Option M7A Power Meter Leveling	1-4
1-4.	ACCESSORIES	1-4
1-4.1	Model 9001 Storage Cabinet	1-4
1-4.2	Model 9202 Plug-in Extender	1-4
1-4.3	Model 9203 Plug-in Inverter	1-4
SECTION II	INSTALLATION	2-1
2-1.	UNPACKING AND INSPECTION	2-1
2-1.1	Removing Contents	2-1
2-1.2	Visual Inspection	2-1
2-1.3	Electrical Inspection	2-1
2-2.	PREPARATION FOR USE	2-1
2-2.1	Frequency Calibration Scales	2-1
2-2.2	Installation in 5000 or 5000A Sweeper	2-1
2-2.3	Installation in 540 or 540B Sweeper	2-3
2-3.	MAINFRAME MODIFICATION TO ACCEPT RF PLUG-INS	2-4
2-4.	REPACKAGING FOR SHIPMENT	2-4
2-5.	SHIPPING METHOD	2-4
2-6.	INSURANCE	2-4
2-7.	RETURNS FOR REPAIR	2-4
SECTION III.	OPERATING INSTRUCTIONS	3-1
3-1.	SCOPE	3-1
3-2.	FRONT-PANEL CONTROLS AND CONNECTORS	3-1
3-3.	INITIAL OPERATING PROCEDURES	3-1
3-4.	HINTS AND PRECAUTIONS	3-1
3-4.1	Changing Plug-ins	3-1
3-4.2	Internal Square Wave Generator	3-1
3-4.3	External Amplitude Modulation	3-1
3-4.4	Leveling	3-4
3-4.5	Fast AM	3-5
3-4.6	Power Meter Leveling	3-5

TABLE OF CONTENTS (Continued)

SECTION/ PARAGRAPH	TITLE	PAGE
SECTION III	OPERATING INSTRUCTIONS (Continued)	
3-4.7	Retrace	3-5
3-4.8	Markers	3-6
3-4.9	Phase Lock Input	3-6
SECTION IV	PERFORMANCE CHECKS AND CALIBRATION	4-1
4-1.	GENERAL	4-1
4-2.	PERFORMANCE CHECKS	4-1
4-2.1	Equipment Required	4-1
4-2.2	Alternate Test Equipment	4-1
4-2.2.1	Power Meter	4-1
4-2.2.2	Directional Detector	4-3
4-2.3	Initial Setup	4-3
4-2.3.1	Description	4-3
4-2.3.2	Procedure	4-3
4-2.4	Frequency Accuracy	4-3
4-2.4.1	Description	4-3
4-2.4.2	Procedure	4-4
4-2.5	Power Output and Internal Leveling Flatness	4-5
4-2.5.1	Description	4-5
4-2.5.2	Procedure	4-5
4-2.6	Power Output and External Leveling Flatness	4-6
4-2.6.1	Description	4-6
4-2.6.2	Procedure	4-7
4-2.7	Unleveled Power Output and Flatness	4-8
4-2.7.1	Description	4-8
4-2.7.2	Procedure	4-8
4-2.8	Residual Amplitude Modulation	4-9
4-2.8.1	Description	4-9
4-2.8.2	Procedure	4-9
4-2.9	Oscillator Pulling and Attenuation	4-11
4-2.9.1	Description	4-11
4-2.9.2	Procedure	4-12
4-2.10	Residual Frequency Modulation	4-13
4-2.10.1	Description	4-13
4-2.10.2	Procedure	4-13
4-2.11	Spurious and Harmonic Content	4-15
4-2.11.1	Description	4-15
4-2.11.2	Procedure	4-15
4-2.12	Internal Amplitude Modulation	4-16
4-2.12.1	Description	4-16
4-2.12.2	Procedure	4-16
4-3.	CALIBRATION	4-18
4-3.1	General	4-18
4-3.2	Equipment Required for Calibration	4-18
4-3.3	Access to Calibration Components	4-18
4-3.3.1	Routine Frequency Calibration	4-18
4-3.3.2	Select-by-Test Calibration	4-22

TABLE OF CONTENTS (Continued)

SECTION/ PARAGRAPH	TITLE	PAGE
SECTION IV	PERFORMANCE CHECKS AND CALIBRATION (Continued)	
4-3.4	Location of Components and Adjustments	4-27
4-3.5	Routine Frequency Calibration	4-27
4-3.5.1	5000 and 5000A Mainframes	4-27
4-3.5.2	540 and 540B Mainframes/579 Adapter	4-28
4-3.6	General Procedure for Selection of Component Values	4-29
4-3.7	Oscillator Voltage Setting	4-30
4-3.7.1	Description	4-30
4-3.7.2	Procedure	4-30
4-3.8	Frequency Range Resistor Selection	4-34
4-3.8.1	Initial Setup	4-34
4-3.8.2	Start and Stop Frequency Range Calibration	4-35
4-3.9	Leveling Loop Calibration	4-37
4-3.9.1	Amplitude Calibration	4-37
4-3.9.2	Leveling Loop Time Constant and Stability Calibration	4-40
4-3.10	1 kHz Square Wave Symmetry	4-43
SECTION V	MAINTENANCE	5-1
5-1.	GENERAL	5-1
5-2.	ROUTINE MAINTENANCE	5-1
5-3.	CALIBRATION	5-1
5-4.	CORRECTIVE MAINTENANCE	5-1
5-4.1	Trouble Isolation	5-1
5-4.1.1	Trouble Isolation Process	5-1
5-4.1.2	Supporting Information	5-2
5-4.1.3	Trouble Isolation Diagrams	5-2
5-4.2	Test Equipment	5-3
5-4.3	Printed Circuit Board Repair	5-3
5-4.4	Component Removal and Reassembly	5-3
5-4.5	Oscillator Module Repair and Replacement	5-4
5-5.	MODIFICATIONS AND OPTIONS	5-5
5-5.1	Option M3, Fast AM (Front Panel Input)	5-5
5-5.2	Option M3A, Fast Am (Rear Panel Input)	5-5
5-5.3	Option M6, Wide Deviation Phase Lock	5-5
5-5.4	Option M7, Negative Power Meter Leveling	5-6
5-5.5	Option M7A, Positive Power Meter Leveling	5-6
SECTION VI	THEORY OF OPERATION	6-1
6-1.	OVERALL FUNCTIONAL DESCRIPTION	6-1
6-1.1	Oscillator Driver	6-1
6-1.2	Amplitude Modulation Functions	6-1
6-2.	OSCILLATOR	6-1
6-3.	MODULATOR	6-4
6-4.	DIRECTIONAL DETECTOR	6-4

TABLE OF CONTENTS (Continued)

SECTION/ PARAGRAPH	TITLE	PAGE
SECTION VII	CHASSIS ASSEMBLY	7-1
7-1.	REPLACEABLE PARTS LIST	7-1
7-1.1	Ordering Replacement Parts	7-1
7-1.2	Explanation of Table 7-3 Columns	7-1
7-1.2.1	Fig. No./Item No.	7-1
7-1.2.2	Ref. Desig.	7-1
7-1.2.3	Use Code	7-1
7-1.2.4	Systron-Donner Part Number	7-1
7-1.2.5	Mfr's Part Number.	7-1
7-1.2.6	Mfr. Code	7-1
7-1.2.7	Description	7-1
7-1.2.8	Qty.	7-2
7-1.3	Parts Breakdown	7-2
7-2.	SCHEMATIC DIAGRAMS	7-2
SECTION VIII	OSCILLATOR DRIVER	8-1
8-1.	GENERAL	8-1
8-2.	THEORY OF OPERATION	8-1
8-2.1	Operating Power	8-1
8-2.2	Overvoltage and Reverse Polarity Protection	8-2
8-2.3	Programming	8-2
8-2.3.1	Gunn Diode Oscillators	8-2
8-2.3.2	Transistor Oscillators.	8-2
8-2.4	Frequency Tuning	8-5
8-2.4.1	Tuning Current Amplifier	8-5
8-2.4.2	Tuning Current Limit	8-5
8-2.4.3	Quieting	8-5
8-2.4.4	FM Tuning Inputs	8-5
8-3.	TROUBLE ISOLATION	8-6
8-4.	REPLACEABLE PARTS LIST	8-6
8-4.1	Ordering Replacement Parts	8-6
8-4.2	Explanation of Columns	8-6
8-4.2.1	Fig. No.	8-6
8-4.2.2	Ref. Desig.	8-6
8-4.2.3	Use Code	8-6
8-4.2.4	Systron-Donner Part Number	8-7
8-4.2.5	Mfr's Part Number.	8-7
8-4.2.6	Mfr. Code	8-7
8-4.2.7	Description	8-7
8-5.	SCHEMATIC DIAGRAMS	8-7
SECTION IX	LEVELER/AMPLITUDE MODULATOR	9-1
9-1	GENERAL	9-1
9-2.	THEORY OF OPERATION	9-1
9-2.1	Drive Levels.	9-1
9-2.2	Operating Modes	9-1
9-2.2.1	Leveling Off Mode.	9-2
9-2.2.2	Fault Mode	9-2

TABLE OF CONTENTS (Continued)

SECTION/ PARAGRAPH	TITLE	PAGE
SECTION IX	LEVELER/AMPLITUDE MODULATOR (Continued)	
9-2.2.3	External Leveling Mode	9-2
9-2.2.4	Markers	9-5
9-2.2.5	Blanking	9-5
9-2.2.6	External AM	9-5
9-2.2.7	1 kHz Generator	9-5
9-2.2.8	Unleveled Indicator	9-5
9-2.2.9	Option M7	9-6
9-2.2.10	Option M7A	9-6
9-3.	TROUBLE ISOLATION	9-6
9-4.	REPLACEABLE PARTS LISTS	9-6
9-4.1	Ordering Replacement Parts	9-6
9-4.2	Explanation of Columns	9-6
9-4.2.1	Fig. No.	9-6
9-4.2.2	Ref. Desig.	9-6
9-4.2.3	Use Code	9-7
9-4.2.4	Systron-Donner Part Number	9-7
9-4.2.5	Mfr's Part Number	9-7
9-4.2.6	Mfr. Code	9-7
9-4.2.7	Description	9-7
9-5.	SCHEMATIC DIAGRAMS	9-7

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE
1-1	Model 5013-2 RF Plug-in	1-1
2-1	Installation in Model 5000A Mainframe	2-2
2-2	Installation in Model 540B with 579 Adapter	2-2
3-1	Model 5013-2 Front-Panel Controls and Connectors	3-2
3-2	Initial Operating Procedures	3-7
4-1	Test Setup for Frequency Accuracy Performance Checks	4-4
4-2	Test Setup for Power Output and Internal Leveling Flatness Performance Check	4-6
4-3	Test Setup for Output Power and External Leveling Flatness Performance Checks	4-8
4-4	Test Setup for Unleveled Power Output and Flatness Performance Check	4-9
4-5	Test Setup for Residual Amplitude Modulation Performance Check	4-10
4-6	Test Setup for Spectrum Analyzer Checks	4-12
4-7	Typical Spectrum Analyzer Display of Residual FM	4-14
4-8	Test Setup for Internal Amplitude Modulation Performance Check	4-17
4-9	Demodulated Square Wave Characteristics	4-17
4-10	Routine Frequency Calibration in 5000-Series Mainframe	4-21
4-11	Routine Frequency Calibration in 540-Series Mainframe/579 Adapter	4-22
4-12	Service and Select-by-Test Calibration Configuration	4-23
4-13	Disassembly Sequence for Service and Select-by-Test Calibration	4-24
4-14	Location of Components, Adjustments, and Reference Test Points	4-25
4-15	Test Setup for Frequency Calibration in 5000-Series Mainframe	4-27
4-16	Test Setup for Frequency Calibration in 540-Series Mainframe/579 Adapter	4-29
4-17	A1 Board Calibration Component Location	4-31
4-18	Test Setup for Oscillator V_C Setting	4-32
4-19	Test Setup for Frequency Range Calibration in 5000-Series Mainframe	4-35
4-20	Test Setup for Frequency Range Calibration in 540-Series Mainframe/579 Adapter	4-36
4-21	Test Setup for Leveling Loop Amplitude Calibration	4-38
4-22	A2 Board Calibration Component Location	4-39
4-23	Test Setup for Leveling Loop Stability Calibration	4-40
4-24	Test Setup for Leveling Loop Response Calibration	4-41
4-25	Demodulated Square Wave Characteristics	4-42
4-26	Test Setup for 1 kHz Symmetry Calibration	4-43
5-1	Troubleshooting Diagrams	5-7
5-2	Oscillator Module Y1 External Components	5-5
6-1	Model 5013-2 Block Diagram	6-2
6-2	Simplified Construction of YIG-tuned Gunn Diode Oscillator	6-3
6-3	Simplified Construction of PIN Diode Modulator	6-4
6-4	Simplified Construction of Directional Detector	6-5
7-1	Model 5013-2 Illustrated Parts Breakdown	7-7
7-2	Model 5013-2 Schematic/Wiring Diagram	7-9
8-1	Oscillator Driver Simplified Schematic Diagram	8-3
8-2	Oscillator Driver A1 Troubleshooting Diagram	8-9
8-3	Oscillator Driver A1 Parts Location/Schematic Diagram	8-19
9-1	Amplitude Modulator Simplified Schematic Diagram	9-3
9-2	Leveler/Amplitude Modulator A2 Troubleshooting Diagram	9-9
9-3	Leveler/Amplitude Modulator A2 Parts Location/Schematic Diagram	9-19
9-4	Power Meter Leveling Assembly A2 Parts Location/Schematic Diagram	9-23

LIST OF TABLES

TABLE	TITLE	PAGE
1-1	Performance Specifications	1-4
3-1	Model 5013-2 RF Plug-in Controls and Connectors	3-2
4-1	Performance Checks	4-2
4-2	Test Equipment Required for Performance Checks	4-2
4-3	Calibration Procedures	4-19
4-4	Test Equipment Required for Calibration	4-20
7-1	Model 5013-2 Chassis Assembly Use Codes	7-2
7-2	Manufacturers' Codes	7-3
7-3	Model 5013-2 RF Plug-in Chassis Parts List	7-4
8-1	Manufacturers' Codes	8-7
8-2	Oscillator Driver Assembly A1 Parts List	8-17
9-1	Manufacturers' Codes	9-7
9-2	Leveler/Amplitude Modulator Assembly A2 Replaceable Parts List	9-17
9-3	Power Meter Leveling Assembly A3 (Option M7) Replaceable Parts List	9-21
9-4	Power Meter Leveling Assembly A3 (Option M7A) Replaceable Parts List	9-21

SECTION I

GENERAL INFORMATION

1-1. SCOPE

This manual provides general information, installation data, operating instructions, circuit descriptions, maintenance data, performance checks, calibration procedures, parts lists, and circuit diagrams for the Systron-Donner (Microwave Division) Model 5013-2 RF Plug-in.

All information applies directly to 5013-2's manufactured after April, 1980. Such units are fitted with YIG-tuned oscillator modules. Model 5013A-2 plug-ins manufactured from 1975 to 1980, although also fitted with YIG-tuned oscillator modules, differ in several details from current production units. The replacement parts lists and plug-in wiring diagram in this manual may not be applicable in all cases. Model 5013-2 plug-ins manufactured before 1975 were equipped with varactor-tuned oscillator modules, and are not covered in this manual.

The Model 5013-2 RF Plug-in Unit, hereinafter referred to as the Model 5013-2, the plug-in, or the unit, is shown in Figure 1-1 installed in a Model 5000A Sweeper Mainframe. Instructions for operation and service of the mainframe are contained within a separate manual.

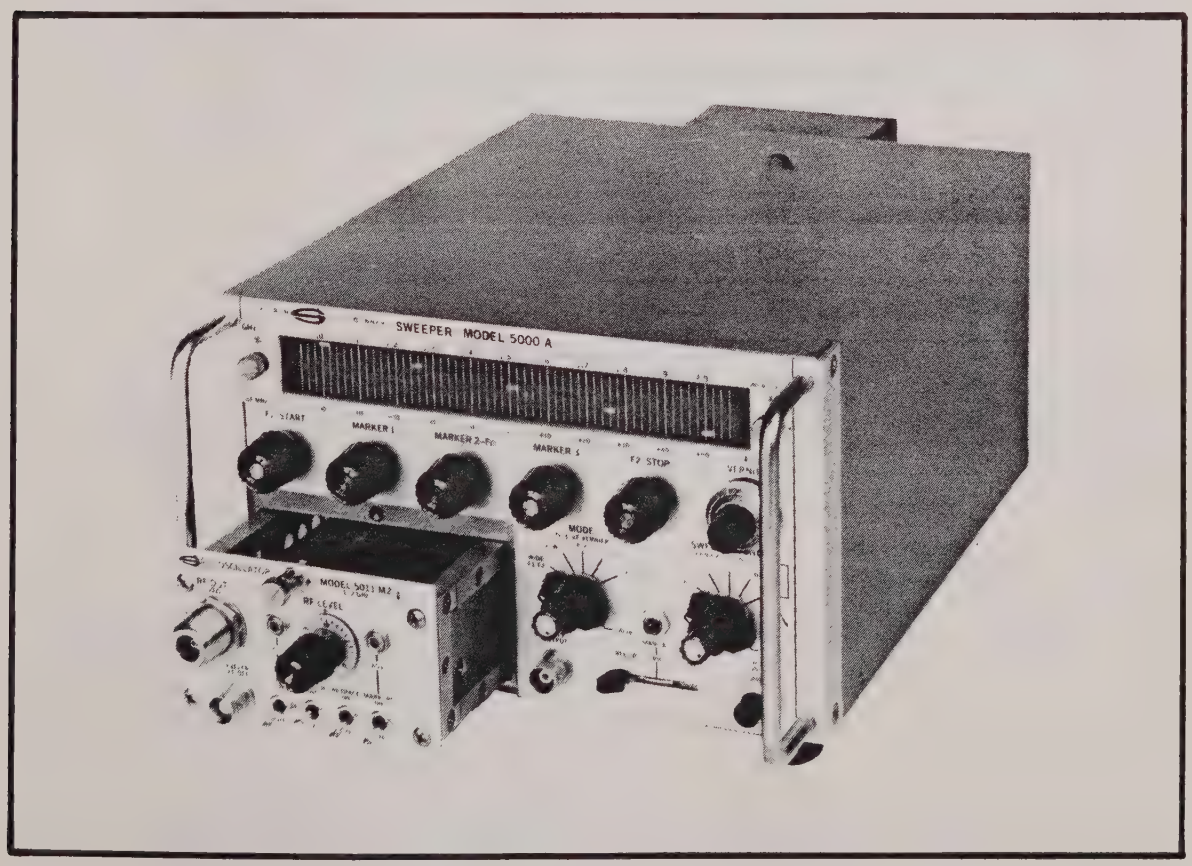


Figure 1-1. Model 5013-2 RF Plug-in

1-2. DESCRIPTION OF EQUIPMENT

The Model 5013-2 operates over the frequency range of 1.7 to 4.2 gigahertz; its output may be swept in either direction over all or any portion of this range, amplitude or frequency-modulated, or utilized as a frequency-agile RF source in systems operation.

The plug-in is supplied with a plastic dial scale calibrated for the 5013-2's usable frequency range of 1.65 to 4.25 gigahertz. This dial scale is installed in the Model 5000-series mainframe at the time the 5013-2 is installed.

Major subassemblies of the 5013-2 include an oscillator driver board, a leveler/amplitude modulator board, an optional power meter leveling board, a solid-state oscillator module, a PIN diode modulator, an optional internal directional detector, several chassis-mounted control switches and potentiometers, and a heatsink assembly containing oscillator operating voltage and sweep current regulator transistors.

1-3. CAPABILITIES AND PERFORMANCE

The Model 5013-2 plug-in, used within an appropriate mainframe, is intended for use in laboratory and field tests of electronic communications components, subsystems, and systems by offering a precisely-calibrated alternative to time-consuming point-by-point testing of amplitude versus frequency characteristics over wide ranges.

Detailed performance specifications for the plug-in are given in Table 1-1.

Salient features of the unit are summarized in the following paragraphs.

1-3.1 External Power Requirements

All required power is supplied by the mainframe in which the 5013-2 is installed.

1-3.2 Frequency Range

The Model 5013-2 uses a fundamental-frequency YIG-tuned transistor oscillator to cover the 1.7 to 4.2 gigahertz range (radar band designation L/S/C, ECM band designation D/E/F/G). Operating and marker frequencies are indicated by colored pointers over the frequency scale of the mainframe. Dial accuracy is plus or minus one percent.

1-3.3 Mainframes

The 5013-2 RF Plug-in may be used in any plug-in sweeper mainframe currently manufactured by Systron-Donner and in all sweeper mainframes manufactured earlier with the *Kruse Electronics* (a division of Systron-Donner) nameplate. Compatibility of the 5013-2 plug-in with these mainframes is delineated in Table 1-1. Model 5013-2 component life may be reduced if the mainframe is not equipped with a cooling fan.

Model 540 mainframes, unless equipped with Option M3 or M4, do not provide the outputs necessary to take advantage of the marker capability of the 5013-2. All Model 540B mainframes are equipped with marker outputs.

1-3.4 Leveling and Amplitude Control

Several methods of leveling (controlling the output amplitude of the plug-in to generate an essentially unvarying power level over the swept frequency range) and amplitude modulation are available. The output may be leveled by the feedback from an internal square-law detector (Option M2 only) or an external negative-output crystal detector, or leveled by the output of a microwave power meter (Options M7 and M7A). The 5013-2 may also be operated in an unleveled mode to obtain maximum peak power over narrow frequency ranges. The output may be modulated by a one kilohertz square wave generated within the 5013-2, or modulated by an externally-supplied input generated by or fed through the mainframe.

1-3.5 Frequency Modulation

In addition to the frequency-control signals from the mainframe, a wideband phase-lock input signal may be coupled through the mainframe directly to an auxiliary tuning coil in the RF oscillator module of the 5013-2. Deviations of up to plus or minus 20 megahertz from the nominal output frequency, at a bandwidth of 400 kilohertz, are possible through the phase lock connection. Deviations of plus or minus 60 megahertz are possible, but at a reduced bandwidth.

1-3.6 Optional Configurations

1.3.6.1 **OPTION M2 INTERNAL LEVELING.** Model 5013-2M2 includes an internal directional detector which is used to level the output of the plug-in when the front-panel **LEVELER** switch is set to **INT**. The output amplitude of the 5013-2M2 is identical within plus or minus 0.7 decibel over the full 1.7 to 4.2 gigahertz range of the plug-in. Option M2 is available concurrently with Options M3/M3A, M6, or M7/M7A.

NOTE

Unless specifically ordered without an internal leveler, all current-production 5013-2 RF plug-ins are equipped with Option M2.

1-3.6.2 **OPTION M3 FAST AMPLITUDE MODULATION.** This option adds a front-panel toggle switch marked **FAST AM/EXT DET** which allows an external attenuation-control voltage to be connected directly to the isolator/modulator assembly through the front-panel **FAST AM/EXT DET** jack. Pulse risetimes and falltimes in *fast AM* mode are about 100 nanoseconds compared with the normal two to ten microsecond pulse response when external inputs are coupled through the leveler/amplitude modulation circuits. Option M3 may be ordered in a 5013-2M2, but is not available in RF plug-ins which are equipped with Option M7 or M7A.

1-3.6.3 **OPTION M3A FAST AMPLITUDE MODULATION.** Model 5013-2M3A accepts an attenuation-control voltage from the mainframe in which it is installed. The specifications and signal requirements are identical to those of the 5013-2M3; Option M3A is not available concurrently with Option M7 or M7A, but is compatible with Option M2.

1-3.6.4 **OPTION M6 WIDE-DEVIATION PHASE LOCK.** This option modifies the 5013-2 to accept external phase-lock inputs into the main frequency tuning circuits rather than into the auxiliary tuning coil of the oscillator module. The output of the 5013-2M6 may be deviated over a wide frequency range, but with restricted bandwidth. A voltage drive is used to frequency-modulate the output rather than the current drive (up to 200 milliamperes) required by the auxiliary tuning coil in unmodified 5013-2's. Option M6 is available concurrently with Options M2, M3/M3A, or M7/M7A.

1-3.6.5 OPTION M7 POWER METER LEVELING. Model 5013-2 RF plug-ins equipped with Option M7 are characterized by an additional front-panel toggle switch marked POWER METER/NORMAL and an additional circuit board mounted within the plug-in. The optional circuitry allows the output amplitude of the plug-in to be controlled by the analog output of any RF power meter which is of negative polarity and has a full-scale amplitude of one volt. The "recorder" output of Hewlett-Packard 431-series and similar power meters supplies the necessary levels for the 5013-2M7. Option M7 is compatible with Option M2, but is not available in 5013-2's with Option M3 or M3A.

1-3.6.6 OPTION M7A POWER METER LEVELING. Option M7A allows the 5013-2 to accept a positive-polarity power meter output as an amplitude-control (leveling) input. The zero to plus one volt "recorder" output of Hewlett-Packard 432, 435, and 436-series RF power meters is typical of acceptable inputs for the 5013-2M7A. Option M7A is compatible with Option M2, but is not available in 5013-2's with Option M3 or M3A.

1-4. ACCESSORIES

1-4.1 Model 9001 Storage Cabinet

The storage cabinet holds four 5000-series RF plug-ins with their dial scales, and bolts on to the side of a 5000 or 5000A mainframe to form a unit in 5¼ inches of rack space. The storage cabinet keeps the plug-ins available, and prevents loss of dial scales or damage to plug-ins.

1-4.2 Model 9202 Plug-in Extender

This unit fits between the sweeper mainframe and the 5013-2 RF plug-in to allow access to internal circuitry for trouble isolation and repair.

1-4.3 Model 9203 Plug-in Inverter

Used in conjunction with the 9202 extender, this maintenance accessory allows physical inversion of the 5013-2 for easier testing or trouble isolation of the oscillator driver circuit board.

Table 1-1. Performance Specifications

ITEM	PARAMETER	SPECIFICATION
1	**Mainframe Compatibility**	
1.1	Model 5000*†	All
1.2	Model 5000A	All
1.3	Model 540*	All, using Model 579* Adapter
1.4	Model 540B*	All, using Model 579* Adapter
2	**Frequency Range**	
2.1	Rated	1.7 to 4.2 GHz
2.2	Usable	1.65 to 4.25 GHz

**Units not in current production*

†5013-2 component life may be reduced in mainframe not equipped with cooling fan

Table 1-1. Performance Specifications (Continued)

ITEM	PARAMETER	SPECIFICATION
3	**Frequency Accuracy**	⩽ ±25 MHz @ 25° ambient and full power output
4	**Frequency Stability**	Percent of output frequency, CW mode
4.1	Δ Temperature	⩽ ±0.05%/°C
4.2	Load VSWR from 1:1 to 3:1, any phase	⩽ ±1.0%
4.3	Δ RF Power, min to max	⩽ ±0.25%
4.4	Δ Line Voltage of ±10%	⩽ ±0.001% (worst-case combination of mainframe and Model 5013-2 specifications)
5	**RF Power Output**	Into 50 Ω load @ 25°C ambient
5.1	Unleveled	⩾ 10 mW (+10 dBm)
5.2	Leveled	⩽ 10 mW (+10 dBm)
6	**Power Control Range**	
6.1	Unleveled	⩾ 30 dB
6.2	Leveled	⩾ 6 dB
7	**Source VSWR (Leveled Mode)**	⩽ 1.6:1 at any output amplitude
8	**Power Variation (Flatness)**	
8.1	Unleveled	⩽ ±3 dB
8.2	Internally Leveled (Option M2)	⩽ ±0.7 dB
8.3	Externally Leveled	⩽ ±0.05 dB (excluding variations in external leveling apparatus)
9	**Spurious Signals**	Amplitude below full rated output, ⩾ 1 MHz from output frequency
9.1	Harmonically-related	⩾ 20 dB
9.2	Non-Harmonic	⩾ 60 dB
10	**Residual FM Deviation, CW Mode**	20 kHz peak, 1 Hz to 30 kHz bandwidth
11	**Residual AM Index**	@ Full power output, 100 kHz bandwidth
11.1	Unleveled	⩾ –46 dB
11.2	Leveled	⩾ –40 dB
12	**Vernier Range**	100 MHz maximum
13	**ΔF Range**	±130 MHz maximum

Table 1-1. Performance Specifications (Continued)

ITEM	PARAMETER	SPECIFICATION
14	**External Phase Lock**	
14.1	Model 5013-2 or 5013-2M2	Normally-supplied configuration
14.1.1	Sensitivity	≈ 300 kHz/mA
14.1.2	Maximum Deviation	±60 MHz
14.1.3	3 dB Bandwidth	400 kHz typical
14.1.4	Maximum Deviation/Rate	20 MHz @ 400 kHz
14.1.5	Linearity	⩽ ±0.3%
14.1.6	Coil Resistance	1.0 Ω nominal
14.1.7	Shunt Capacitance	≈ 50 pF
14.1.8	Coil Inductance	1.25 μH nominal
14.1.9	Maximum Current	200 mA
14.1.10	Maximum Voltage	200 mV
14.2	Model 5013-2M6	With wide-deviation phase-lock option
14.2.1	Sensitivity	≈ 25 MHz/V
14.2.2	3 dB Bandwidth	≈ 10 kHz
14.2.3	Impedance	≈ 1 MΩ
14.2.4	Maximum Voltage	±100 V
15	**External Leveling**	
15.1	Model 5013-2 or 5013-2M2	Normally-supplied configuration
15.1.1	Sensitivity	–10 mV/mW
15.1.2	Impedance	5 kΩ nominal
15.2	Model 5013-2M7	With negative power meter leveling option
15.2.1	Sensitivity	–1 V/mW @ 1 mW full scale
15.2.2	Maximum Input	–10 V
15.2.3	Impedance	5 kΩ nominal
15.3	Model 5013-2M7A	With positive power meter leveling option
15.3.1	Sensitivity	+1 V/mW @ 1 mW full scale
15.3.2	Maximum Input	+10 V
15.3.3	Impedance	⩾ 10 kΩ
16	**Markers**	
16.1	Minimum Marker Amplitude	⩽ 0.2 dB in leveled output mode
16.2	Maximum Marker Amplitude	⩾ 2 dB in leveled output mode
16.3	Marker Polarity	Reduces RF output amplitude
17	**Internal Amplitude Modulation**	
17.1	Waveform	Square wave
17.2	Frequency	1000 Hz
17.3	Stability	⩽ ±1 Hz
17.4	Adjustment Range	⩾ ±50 Hz

Table 1-1. Performance Specifications (Continued)

ITEM	PARAMETER	SPECIFICATION
17	**Internal Amplitude Modulation (Cont.)**	
17.5	Symmetry	⩽ 5%
17.6	Risetime	⩽ 10 μs at maximum leveled output
17.7	Falltime	⩽ 10 μs at maximum leveled output
17.8	On/Off Ratio	⩾ 30 dB
18	**External Amplitude Modulation**	
18.1	Model 5013-2 or 5013-2M2	Normally-supplied configuration
18.1.1	Input Port	Mainframe *external A.M.* connector
18.1.2	Sensitivity	+100 mV/mW in leveled mode
18.1.3	Maximum Input	+10 V peak
18.1.4	Impedance	⩾ 10 kΩ
18.1.5	3 dB Bandwidth	30 kHz nominal
18.2	Model 5013-2M3	With fast AM option
18.2.1	Input Port	Plug-in **EXT DET/FAST AM** connector
18.2.2	Sensitivity	1 to 2 dB/mA
18.2.3	Maximum Current	+50 mAdc
18.2.4	Maximum Voltage Range	–600 mV to +6 Vdc
18.2.5	Risetime	⩽ 100 ns
18.2.6	Falltime	⩽ 100 ns
18.3	Model 5013-2M3A	With fast AM option
18.3.1	Input Port	Mainframe *external A.M.* connector
18.3.2	Sensitivity	1 to 2 dB/mA
18.3.3	Maximum Current	+50 mAdc
18.3.4	Maximum Voltage Range	–600 mV to +6 Vdc
18.3.5	Risetime	⩽ 100 ns
18.3.6	Falltime	⩽ 100 ns
19	**Environment**	
19.1	Operating Temperature	0 to +55°C (+32 to +131°F) ambient
19.2	Storage Temperature	–55 to +85°C (–67 to +185°F)
19.3	Altitude	0 to 10,000 feet (3,05 kilometers)
20	**Dimensions**	
20.1	Height	2.40 inches (6,1 centimeters)
20.2	Width	3.87 inches (9,83 centimeters)
20.3	Depth	9.625 inches (24,5 centimeters)
21	**Weight**	≈ 3 pounds (1,36 kilograms)

SECTION II

INSTALLATION

2-1. UNPACKING AND INSPECTION

The RF plug-in is shipped in a specially-constructed container to provide maximum protection during transit. Use care when unpacking to prevent damage to the equipment, such as the front panel finish, switches, connectors, etc.

2-1.1 Removing Contents

To remove the plug-in from the shipping container, cut and fold back the outer carton top flaps, remove the top protective cushion, lift the plug-in clear from shipping container, and remove it from the dust protection bag.

2-1.2 Visual Inspection

The plug-in was carefully tested and inspected prior to shipment. Carefully inspect it for damage incurred during shipment. If the plug-in is damaged in any way, notify the freight carrier immediately. Do not discard any packing materials, as the freight carrier's agent will wish to examine them.

2-1.3 Electrical Inspection

Conformance with operation and performance specifications may be verified by following the *performance check* procedures in Section IV of this manual.

2-2. PREPARATION FOR USE

2-2.1 Frequency Calibration Scales

Depending upon the type of sweeper with which the RF plug-in is to be used, a clear plastic dial scale (5000 and 5000A) or a metal dial drum (540/579 or 540B/579) is required. The clear plastic dial scale is shipped with the plug-in at no charge.

2-2.2 Installation in 5000 or 5000A Sweeper (Figure 2-1)

To install a plug-in in one of these units:

1. Remove the clear plastic dial scale from the bracket on the right side of the plug-in by loosening the two captive knurled knobs.

2. Insert the RF plug-in through the rectangular hole in the sweeper front panel.

CAUTION

DO NOT FORCE THE RF PLUG-IN IF IT DOES NOT SLIDE IN EASILY. THE PLUG-IN OR MAINFRAME MAY BE DAMAGED IF FORCE IS USED. REFER TO PARAGRAPH 2-3 IN CASE OF DIFFICULTY.

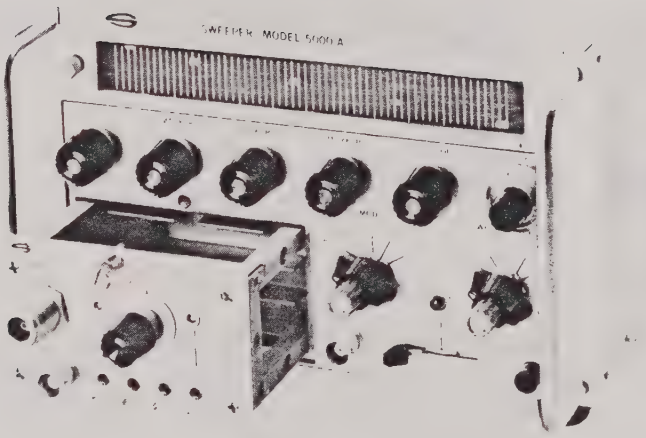


Figure 2-1. Installation in Model 5000A Mainframe

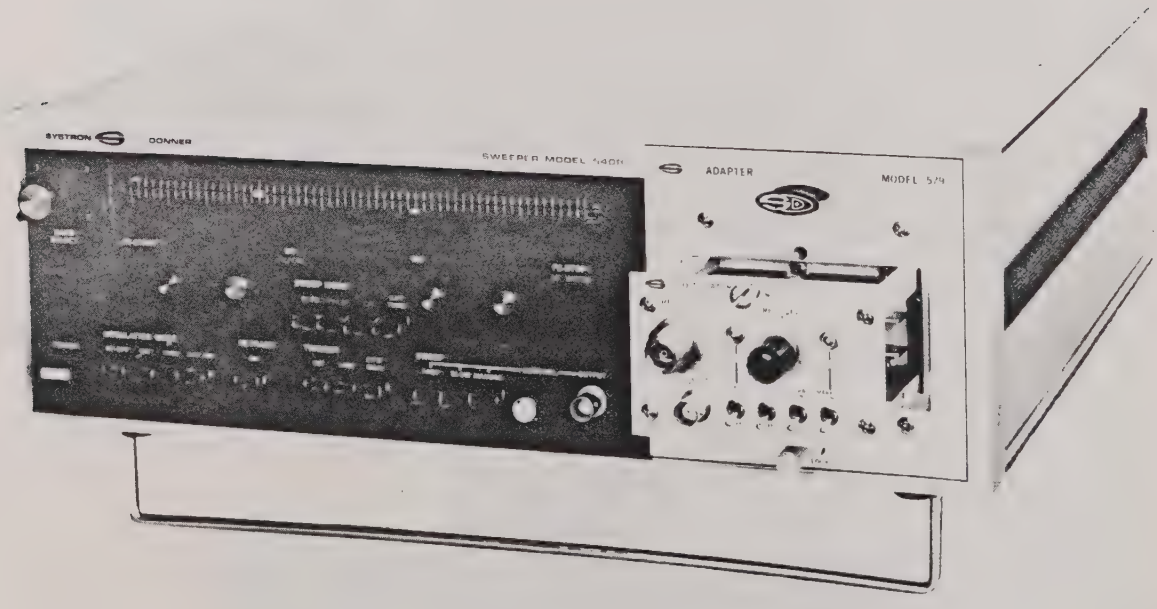


Figure 2-2. Installation in Model 540B with 579 Adapter

3. Lock the plug-in in place by turning the small knob at the top of the plug-in clockwise.

4. Install the clear plastic dial plate in the large rectangular cutout at the top of the sweeper.

5. Simultaneously tighten both knurled screws by turning them clockwise until they are finger tight. Be sure the dial fits in the panel without binding.

2-2.3 Installation in 540 or 540B Sweeper (Figure 2-2)

A single 5000-series RF plug-in may be installed in a Model 540 or 540B sweeper if it has been fitted with a Model 579 adapter. (These units are not in current production.)

1. Remove the clear plastic dial scale from the bracket on the right side of the plug-in by loosening the two captive knurled knobs. The dial scale is not used in this application.

2. Insert the RF plug-in into the rectangular hole in the center of the 579 adapter.

CAUTION

DO NOT FORCE THE RF PLUG-IN IF IT DOES NOT SLIDE IN EASILY. THE PLUG-IN OR MAINFRAME MAY BE DAMAGED IF FORCE IS USED. REFER TO PARAGRAPH 2-3 IN CASE OF DIFFICULTY.

3. Lock the plug-in in place by turning the small knob at the top of the plug-in clockwise.

4. Set the **1 KHZ** switch of the RF plug-in to **OFF**.

5. Set the **RETRACE** switch of the RF plug-in to **ON**.

6. Connect a BNC cable between the **MARKER INPUT** connector on the rear panel of the 579 adapter and the **AMPLITUDE MARKER OUTPUT** connector on the rear panel of the 540B, 540M3, or 540M4 mainframe.

7. If necessary, install a new dial drum in the mainframe following steps *8* through *13*.

8. Remove the top cover of the mainframe; it is held in place with two screws.

9. Face the instrument, holding the dial scale drum with its smooth, rounded end knob to the right.

10. Push the smooth knob into its mating receptacle near the plug-in compartment shield. The spring will give way, allowing you to lower the left side of the drum.

11. Snap the drum into place and align the locating key with the mating groove in the left side of the drum assembly.

12. Rotate the **BAND SELECT** knob to ensure smooth operation of the drum assembly.

13. Set the **BAND SELECT** knob so that the dial scale matching the range of the RF plug-in is displayed.

14. Replace the top cover using the shorter screw on the right side.

2-3. MAINFRAME MODIFICATION TO ACCEPT RF PLUG-INS

Sweeper mainframes manufactured prior to January 1979 may require physical modification to accept some RF plug-in models manufactured after this date. The affected RF plug-in models include:

1. Model 5015 (8 to 12.4 GHz)
2. Model 5015-2 (7 to 11 GHz)
3. Model 5015-5 (10.7 to 11.7 GHz)
4. Model 5016 (12.4 to 18 GHz)
5. Model 5016-2 (10 to 15 GHz)
6. Model 5018 (18 to 26.5 GHz)
7. Model 5030 (1 to 4 GHz)
8. Model 5031 (8 to 18 GHz)

Modification instructions and required parts will be supplied upon request. Please supply the model number(s) and serial number(s) of the sweeper mainframes for which modification kits are required.

2-4. REPACKAGING FOR SHIPMENT

If the plug-in is to be packaged for re-shipment, use the original shipping container and packaging material. If the original packaging has been discarded or is not in condition for re-use, perform the following packaging procedure. The plug-in may be shipped while it is housed within a mainframe:

1. Wrap the instrument in a heavy paper wrapping or plastic protective covering.
2. Place protective cushion in the bottom of shipping carton and place the instrument on the cushion.
3. Surround the remaining sides and top with additional protective cushions. Place front and rear cushions to provide support of the instrument without resting on the controls or connectors.

2-5. SHIPPING METHOD

This instrument should be shipped only by truck freight, air freight, or parcel delivery service. If it is shipped by parcel post, damage is likely to occur. Systron-Donner is not responsible for units damaged in shipment to the factory for repair, whether such units are in warranty or not.

2-6. INSURANCE

For your own protection, insure the unit for full value whenever it is shipped.

2-7. RETURNS FOR REPAIR

Be sure to fully identify any instrument that is returned to Systron-Donner for repair of any kind, in-warranty or not. The paperwork with the unit must show the instrument serial number, a description of the problem or malfunction to be corrected, and the exact address to which the instrument should be returned when repair is completed. Please also include the *name* and *telephone number* of the cognizant party in your organization; this may speed the identification and repair of malfunctions.

SECTION III

OPERATING INSTRUCTIONS

3-1. SCOPE

This section contains descriptions of all operating controls and indicators, an initial operating procedure, and a summary of precautions for proper usage of the 5013-2 RF plug-in. Specific operating instructions for the sweeper mainframe are contained in the manual supplied with the sweeper.

3-2. FRONT-PANEL CONTROLS AND CONNECTORS

The front-panel controls and connectors are illustrated in Figure 3-1, and are listed and described in Table 3-1.

3-3. INITIAL OPERATING PROCEDURES

Figure 3-2 contains condensed initial operating procedures for the 5013-2 and 5000A mainframe. These procedures are applicable to any swept signal measurement situation over the operating range of the plug-in, and generally apply to any mainframe in which the 5013-2 may be used.

3-4. HINTS AND PRECAUTIONS

3-4.1 Changing Plug-ins

It is imperative that the mainframe power be turned off before removing or inserting the 5013-2 RF plug-in. Serious damage to the 5013-2 or mainframe could result if this caution is ignored.

3-4.2 Internal Square Wave Generator

The internal one kilohertz generator drives the modulator with a square wave, reducing the RF output of the 5013-2 to zero on positive peaks. Most VSWR amplifiers and ratiometers will respond to the demodulated one kilohertz signal. If one of these units is being used, the **1 KHZ ADJ** control should be tuned for maximum response of the meter in use before measurements are made. Tuning the plug-in modulating frequency to that of the VSWR amplifier will considerably increase the measurement accuracy and signal-to-noise ratio.

If the 5013-2 is used in a 540-series mainframe with 579 adapter, the **1 KHZ** switch of the 5013-2 should be set to **OFF**; these mainframes have internal one kilohertz generators. The **MODULATION MODE 1 KHZ** switch of the 540 or 540B should be used to control the one kilohertz modulating signal. The frequency of the square wave may be adjusted with a mainframe rear-panel adjustment.

3-4.3 External Amplitude Modulation

Each mainframe in which the 5013-2 may be used has a rear-panel connector through which external amplitude modulation signals may be coupled to the leveler/amplitude modulation circuits, where they are summed with all other amplitude modulation signals (internal one kilohertz, **RF LEVEL** control setting, retrace blanking, and markers).

This external input is dc-coupled, at an approximate sensitivity of minus 100 millivolts per milliwatt of RF output. A negative-polarity input will decrease the output amplitude of the 5013-2; positive inputs will increase the amplitude. An input level of minus seven volts is sufficient to overcome the effects of all other amplitude-control signals, functioning as a remote "RF off" signal.

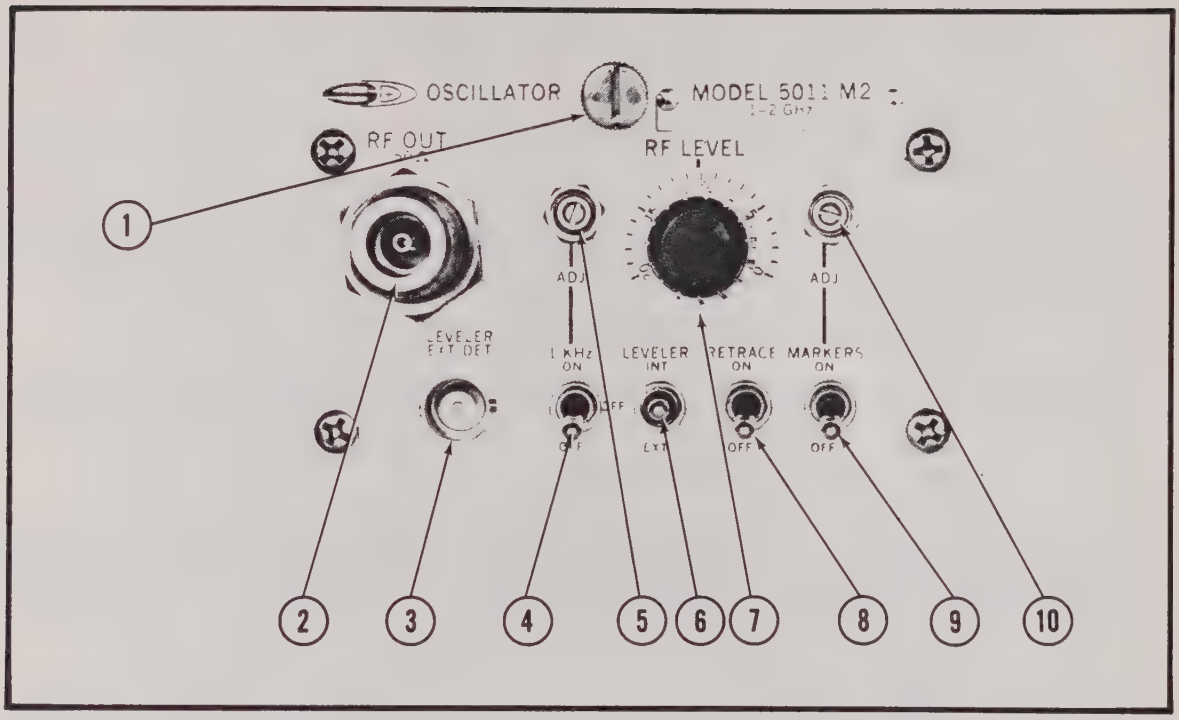


Figure 3-1. Model 5013-2 Front-Panel Controls and Connectors

Table 3-1. Model 5013-2 RF Plug-in Controls and Connectors

INDEX NO. (FIG. 3-1)	FRONT PANEL NAME AND DESCRIPTION	FUNCTION
1	Locking Screw	Used to lock plug-in in place in mainframe. *NOTE: This knob must be tightened to ensure low noise and proper seating of the interface connector.*
2	**RF OUT 50Ω** connector	The RF output of the plug-in is coupled through the precision Type N connector. The output impedance at this port is 50 Ω.
3	**LEVELER EXT DET** connector	Accepts video output of external directional detector for precision power leveling at the load. Sensitivity is approximately 10 mV/mW of output power. Input impedance is 5 kΩ, negative polarity. For Model 5013-2M7, a zero to –1 V power meter "recorder" output signal may be used instead of the output of a crystal detector.

Table 3-1. Model 5013-2 RF Plug-in Controls and Connectors (Continued)

INDEX NO. (FIG. 3-1)	FRONT PANEL NAME AND DESCRIPTION	FUNCTION
4	**1 KHZ** switch	When set to **ON**, 100% amplitude-modulates the RF output of the 5013-2 with a 1 kHz square wave.
5	**1 KHZ ADJ** control	Controls the frequency of the internal 1 kHz square wave generator from ≈ 950 to 1050 Hz.
6	**LEVELER** switch	Selects method of leveling RF output amplitude of 5013-2:
	INT	The internal directional detector (Model 5013-2M2 only) is used to maintain the amplitude at the **RF OUT 50Ω** connector constant over the full 1.7 to 4.2 GHz range.
	OFF	The RF output is unleveled but controllable; the **RF LEVEL** control is used to adjust the output amplitude of the 5013-2. Maximum peak power output is available in this position. This position is used for external power meter leveling with Model 5013-2M7.
	EXT	The 5013-2 is externally leveled using an appropriate directional detector. In this position, an external negative voltage at the **LEVELER EXT DET** connector is used to control the RF output.
7	**RF LEVEL** control	Setting determines the RF output amplitude of the 5013-2. This control typically has a range of over 30 dB in unleveled and at least 6 dB in leveled mode.
8	**RETRACE** switch	When set to **ON**, RF output is left on during the time the sweep circuits are retracing. When the switch is set to **OFF**, the internal modulator is automatically set to maximum attenuation during sweep retrace.
9	**MARKERS** switch	When set to **ON**, turns on RF dip markers as set by mainframe controls. The switch is set to **OFF** when the 5013-2 is used in any sweeper mainframe other than the 5000 or 5000A.

Table 3-1. Model 5013-2 RF Plug-in Controls and Connectors (Continued)

INDEX NO. (FIG. 3-1)	FRONT PANEL NAME AND DESCRIPTION	FUNCTION
10	**MARKERS ADJ** control	Setting determines amount of RF signal attenuation at marker points and thus the size of the markers. Range of this control when the 5013-2 is operating in leveled mode is ≈ 0.2 to 2.0 dB.
Not Shown	**FAST AM** switch	Present in Models 5013-2M3 and 5013-2M3A; this switch is set to **EXT DET** to use the leveling, amplitude-control, and modulation functions of the mainframe and RF plug-in. When this switch is set to **FAST AM**, an external amplitude-control signal may be connected directly to the PIN-diode modulator through the **EXT DET/FAST AM** connector (Option M3) or through the *external A.M.* jack of the mainframe (Option M3A).
Not Shown	**POWER METER** switch	Present in Models 5013-2M7 and 5013-2M7A; this switch is set to **NORMAL** in order to level the RF output with an external directional detector. The 0 to −1 V (Option M7) or 0 to +1 V (Option M7A) output of an RF power meter is used for leveling when the switch is set to **POWER METER**.

3-4.4 Leveling

Leveling is the process which overcomes the natural tendency of radio frequency sources to generate different power levels at different frequencies due to resonances, losses, and other frequency-sensitive factors. The desired end result is identical output power over the full 1.7 to 4.2 gigahertz range of the 5013-2. When internal leveling is used, the amplitude at the **RF OUT 50Ω** connector is essentially identical for all output frequencies.

Where long output cables are needed, external leveling should be used, as closely as possible to the point of measurement.

The front-panel **LEVELER EXT DET** connector accepts the input from a directional detector at an approximate sensitivity of minus ten millivolts per milliwatt. The actual power level at the output connector of the directional detector may be measured with a microwave power meter and correlated with dial markings on the **RF LEVEL** control as reference points.

An effective directional detector can be assembled from a 13 decibel directional coupler which is flat over the 1.7 to 4.2 gigahertz band and a microwave crystal detector with matching square-law load.

If the 5013-2 is equipped with power meter leveling option M7 or M7A, the **POWER METER/ NORMAL** switch must be set to **NORMAL** when the internal leveler (Option M2) or an external crystal detector is used as the leveling element. Response time of the leveling circuitry is slowed considerably in a power meter leveling mode.

NOTE

If the **LEVELER** switch is set to **EXT**, and an external leveler is not connected, it will not be possible to control the output amplitude with the **RF LEVEL** control. The RF output will either be completely off or at maximum amplitude. This is also true if the **LEVELER** switch is set to **INT** in a 5013-2 which has been ordered without Option M2 Internal Leveling.

3-4.5 Fast AM

Model 5013-2M3 and 5013-2M3A RF plug-ins will accept an external amplitude-control input of positive polarity directly to the PIN diode modulator. The attenuation factor is approximately linear at one-half to one decibel per milliampere to a maximum of 20 to 50 milliamperes for the rated maximum attenuation of 30 decibels. (The exact attenuation factor for a particular 5013-2 must be determined experimentally by the user.) The maximum allowable amplitude for this input is six volts positive or 600 millivolts negative.

The control-current input port for Model 5013-2M3 is the front-panel **FAST AM/EXT DET** jack; the input port for Model 5013-2M3A is the rear-panel *external A.M.* jack of the mainframe or adapter.

To use the fast AM capability, set the 5013-2's **FAST AM/EXT DET** switch to **FAST AM** and the **LEVELER** switch to **OFF**. The leveling, one kilohertz, retrace blanking, and marker functions of the 5013-2 will not be available in *fast AM* mode.

3-4.6 Power Meter Leveling

Model 5013-2M7 RF plug-ins will accept an external leveling input from a negative-output crystal detector as described in Paragraph 3-4.4 above, or may be leveled with the analog "recorder" output of any power meter which has a negative one-volt level corresponding to full scale. Power meters such as Hewlett-Packard 431B, 431C, and many others provide this output. The **LEVELER** switch must be set to **EXT** and the **POWER METER/NORMAL** switch to **POWER METER**; the input is connected to the **LEVELER EXT DET** connector.

Model 5013-2M7A is similar, but accepts the positive one-volt output of a power meter such as Hewlett-Packard 432, 435, 436, and units from other manufacturers. To use positive power meter leveling, the front-panel **POWER METER/NORMAL** switch must be set to **NORMAL**, the **LEVELER** switch to **OFF**, and the power meter output connected to the rear-panel *external A.M.* jack of the mainframe.

Both modes of power meter leveling are suitable for use only at the slower sweep speeds. The thermoelectric detection elements used in most power meters have relatively slow response to amplitude changes and will not properly level the 5013-2 when the mainframe is operating in a fast sweep mode. The response time of the 5013-2 leveling circuitry is also reduced in power meter leveling mode, and will not accept fast amplitude changes.

3-4.7 Retrace

When the front-panel **RETRACE** switch is set to **OFF**, the internal modulator of the 5013-2 is automatically driven to maximum attenuation during the time the sweep ramp from the mainframe is retracing. This eliminates a possibly confusing extra trace from the oscilloscope or display unit screen. However, under certain circumstances, the **RETRACE** switch should be set to **ON** where it is desired that the RF output of the 5013-2 remain on at all times, such as when average power is being measured, when certain chart recorders are being used, and when phase-locked systems are in use. The fast-rising pulses at both ends of sweep might cause measurement errors.

If an RF power meter is being used to measure output power of the plug-in at high sweep speeds, it will indicate average power over the swept band, provided the sweep retrace is not blanked. Setting the **RETRACE** switch to **OFF** will blank the RF output during sweep retrace and cause the power meter to indicate a lower amplitude than is actually present. The fast-rising and falling voltages of the beginning and end of sweep retrace will also cause disturbances when logarithmic converters or crystal-detector type logarithmic power meters are used, causing abnormal power levels to be indicated at fast sweep speeds.

If the 5013-2 is used in a 540 or 540B mainframe with a 579 adapter, the plug-in's **RETRACE** switch should be left at **ON**, and the **RETRACE** switch on the mainframe or controller used to select the retrace mode.

3-4.8 Markers

Markers are generated in the 5013-2 plug-in by momentarily reducing the RF output power in response to marker signals from the mainframe (Model 540 mainframes must be equipped with Option M3 or M4).

The size of the markers is controlled by the front-panel **MARKERS ADJ** potentiometer; the minimum size is equivalent to a power reduction of about 0.2 decibel. Under certain circumstances, RF dip markers may not be usable; where there is a great deal of attenuation in the system under test, or when the 5013-2 is generating maximum unleveled power, the markers may not be visible on the detected waveform. In these cases, the other methods of marker generation (video bypass, intensity, sweep stop) described in the mainframe manual should be used. Very high "Q" circuits may cause oscillations (ringing) at marker points due to the fast rise and fall times of the marker pulses. In these cases, too, an alternate method of marker generation *not* involving output amplitude reduction should be employed.

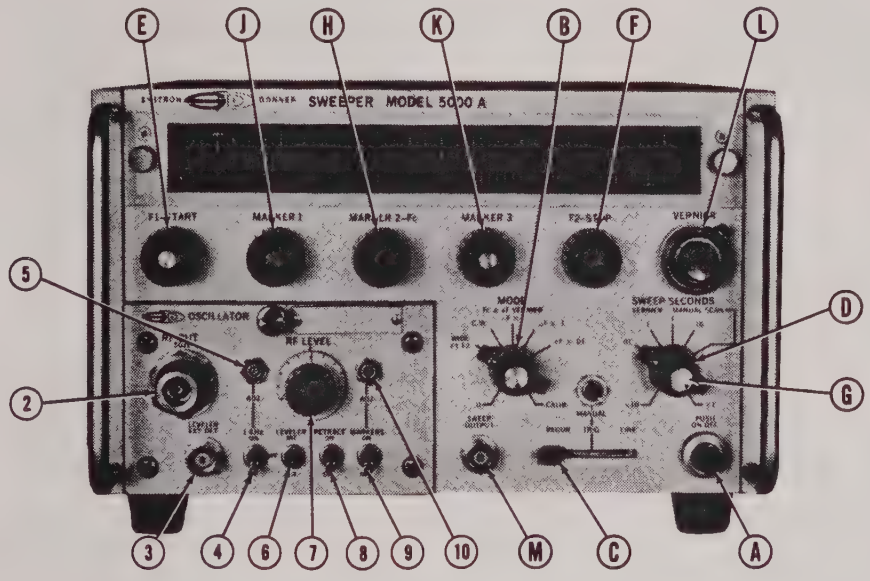
3-4.9 Phase Lock Input

The phase lock input for the 5013-2 RF plug-in is physically located on the rear panel of the mainframe or adapter, but electrically connects directly to the oscillator module in the plug-in. Generally, the phase lock input is used to directly control the oscillator frequency to maintain a fixed output frequency or to generate FM. In the first case, the output of a discriminator is commonly used; in the second case, the ac-coupled output of a low-frequency oscillator is used.

Considerable current is required to drive the FM coil in the oscillator; up to one-fifth ampere is needed to deviate the output frequency to its rated maximum of 60 megahertz. If wider deviation is required, Model 5013-2M6 with the optional *wide phase-lock* connection should be used. Modification instructions for converting the 5013-2 to *wide phase-lock* operation can be found in Section V of this manual.

Response of the phase lock input is linear with current at a sensitivity of 300 kilohertz per milliampere. Frequency response is approximately 400 kilohertz (half-power points). When the wide phase-lock option is used, the amplitude response is linear at about 20 megahertz per volt with a frequency response of about 10 kilohertz. The polarity of the phase lock input determines the direction of frequency deviation: positive inputs increase the output frequency and negative inputs decrease it.

To ensure low residual FM in the RF output, it is important that the phase lock input be short-circuited when it is not in use. The **PHASE LOCK** jack on the mainframe or adapter is self-shorting when the mating plug is removed. An unterminated lead connected to the **PHASE LOCK** jack will act as an antenna, coupling electromagnetic and electrostatic noise into the frequency-control circuits of the 5013-2.



A. PRELIMINARY CONTROL SETTINGS IN 5000A

Control	Setting
RF LEVEL (7)	Maximum CCW
PUSH ON-OFF (A)	Depressed to turn mainframe power on
RF OUT 50 Ω (2)	Connect suitable RF output cable to circuit or device to be sweep tested
1 KHZ (4)	OFF
MODE (B)	WIDE F1–F2
RETRACE (8)	OFF
MARKERS (9)	OFF
TRIGGER (C)	RECUR
SWEEP SECONDS (D)	.1
SWEEP SECONDS VERNIER (G)	x1

B. TYPICAL TEST METHOD IN 5000A

Control	Setting
F1–START (E)	Adjust so *GOLD* dial indicator is at lowest frequency of interest

Figure 3-2. Initial Operating Procedures (Sheet 1 of 3)

F2–STOP (F)	Adjust so *ORANGE* dial indicator is at highest frequency of interest
LEVELER (6)	**INT** (**OFF** if 5013-2 does not have Option M2)
RF LEVEL (7)	Slowly increase the RF output of the plug-in while observing detected response of test item on display unit (oscilloscope or chart recorder).

Continue to increase the RF amplitude until the desired power level is reached. If an external leveler is used, connect its input to **LEVELER EXT DET** (3) and set the **LEVELER** switch (6) to **EXT**. Increase power until the output becomes unleveled as indicated on the display unit trace. Reduce setting of **RF LEVEL** control (7) as required.

If the shape of the swept response changes as a function of **SWEEP SECONDS VERNIER** (G) setting, reduce sweep speed until the distortion is no longer evident. This effect may be noticed when sweeping high-Q circuits, when the crystal detector output capacitor is of high value, or when logarithmic converters are used at the display unit input. In general, use the lowest sweep speed which allows comfortable viewing of the display unit trace with minimal distortion.

To use direct reading frequency markers, set **MARKERS** switch (9) to **ON**.

Adjust **MARKER 2** (H) until the pip on the trace is over an area of interest in the swept response curve. The frequency of the discontinuity, anomaly, or other event is shown by the *RED* dial indicator. Adjust **MARKER 1** (J) and **MARKER 3** (K) to calibrate the swept response curve at points on either side of the frequency of interest. In many cases, it will be desirable to examine parts of the trace using narrow sweeps without disturbing the F1—F2 settings:

Control	Setting
MARKER 2–Fc (H)	Adjust so marker 2 is centered in the narrow band area of interest
MODE (B)	**Fc ± ΔF x 1**
MARKER 1 (J)	Set marker 1 so *GREEN* indicator shows lower calibration frequency on lower part of frequency scale
MARKER 3 (K)	Set marker 3 so *BLUE* indicator shows upper calibration frequency on lower part of frequency scale
Fc ± ΔF VERNIER (M)	Set to **CALIB.** When ΔF sweep width is reduced by rotating control CCW, Markers 1 and 3 become uncalibrated.

Figure 3-2. Initial Operating Procedures (Sheet 2 of 3)

C. OTHER CONTROLS

1. **TRIGGER (C)** : Trigger modes other than recurrent have specific uses. In line trigger mode, the effects of power ground loops or power line-frequency noise in the displayed swept response curve can be minimized by synchronizing the sweep with these components. Manual mode is used for single sweeps or sweeps triggered on command when chart recorders or other plotting devices are used.

2. **RETRACE (8)** : If a fast-rising pulse caused by turning off the RF output of the plug-in during retrace is causing distortion at the ends of the display unit trace, depress this pushbutton to leave RF on during retrace. This is also recommended if power meters are used in the system.

3. **1 KHZ (4)** : Use the 1 kHz square wave to amplitude-modulate the RF output for use with VSWR detectors or ratiometers.

4. **VERNIER (L)** : For fine frequency adjustments in CW and narrow Fc ± ΔF sweeps; read frequency up to 100 MHz which must be added to frequency indicated by the *RED* indicator on upper part of dial scale. VERNIER must be set to 0.0 (full ccw) to ensure accuracy of frequency readings.

Figure 3-2. Initial Operating Procedures (Sheet 3 of 3)

SECTION IV

PERFORMANCE CHECKS AND CALIBRATION

4-1. GENERAL

This section contains procedures for testing the electrical performance of the 5013-2 RF Plug-in and calibrating the unit when necessary.

Calibration accuracy checks should be undertaken only by qualified personnel with sufficient experience and knowledge to ensure that proper test methods are employed. Use standard maintenance and metrology practices when working on the plug-in.

4-2. PERFORMANCE CHECKS

This paragraph contains the performance check procedures listed in Table 4-1. These performance checks verify that the instrument meets the applicable performance specifications in Table 1-1. Failure to meet the specified performance limits indicates the need for repair or recalibration in accordance with the procedure of Paragraph 4-3.

The following performance checks may be made at any time, and should be performed annually in the order indicated. If these checks reveal the need for repair or recalibration of the instrument, it should be returned to Systron-Donner or another qualified metrology laboratory so that the calibration procedure in Paragraph 4-3 may be accomplished.

4-2.1 Equipment Required

The test equipment required to check performance of the plug-in is listed in Table 4-2. All test equipment should bear evidence of recent calibration by a qualified metrology laboratory. Equipment equivalent to that listed in Table 4-2 may be used, but care should be taken to ensure that the rated accuracy of the equipment used is truly equivalent to that cited. In any case, the maximum rated inaccuracy of a piece of test equipment used to measure any parameter must not be greater than one-tenth the maximum inaccuracy which can be tolerated in the measurement.

4-2.2 Alternate Test Equipment

In many cases the recommended test equipment will not be available but alternate test equipment can be constructed from standard coaxial components and instruments.

4-2.2.1 **POWER METER.** The Systron-Donner Model 4020A is listed because it combines the features of an RF power meter and a logarithmic converter; in measurements requiring readout in logarithmic terms (decibel measurements), the 4020A will read directly in terms of the measurements. The output of the 4020A, when fed to a general-purpose linear oscilloscope, allows measurement in terms of 1.0 or 10.0 decibels per linear graticule division.

If such a power meter is not available, any high-quality power meter with a dynamic range of 50 decibels may be used for power measurements. Some acceptable instruments are Hewlett-Packard Model 432, 435, or 436, General Microwave 475 or 476, etc. (all with appropriate temperature-compensated thermistor mounts rated to operate over the 1.7 to 4.2 gigahertz band

Table 4-1. Performance Checks

PARAGRAPH NUMBER	PROCEDURE	SPECIFICATION REFERENCE ITEM (TABLE 1-1)
4-2.4	Frequency Accuracy	2, 3
4-2.5	Power Output and Internal Leveling Flatness	5, 8
4-2.6	Power Output and External Leveling Flatness	5, 8
4-2.7	Unleveled Power Output and Flatness	5, 8
4-2.8	Residual Amplitude Modulation	11
4-2.9	Oscillator Pulling and Attenuation	4, 6
4-2.10	Residual Frequency Modulation	10
4-2.11	Spurious and Harmonic Content	9
4-2.12	Internal Amplitude Modulation	17

Table 4-2. Test Equipment Required for Performance Checks

ITEM	TYPE OF EQUIPMENT	CHARACTERISTICS	RECOMMENDED MODEL*
1	Sweeper Mainframe	5013-2-compatible	Systron-Donner 5000A
2	Frequency Counter	1.7 to 4.2 GHz	Systron-Donner 6244A
3	Spectrum Analyzer	1.7 to 12.6 GHz; 10 kHz/Div. resolution, 10 dB/Div.	Tektronix 492
4	Digital Voltmeter	Resolution 1 mV on 10 V scale	Systron-Donner 7141A
5	Oscilloscope	High sensitivity with variable bandwidth	Tektronix 5403 mainframe, 5A22 vertical amplifier, 5B42 delaying time base
6	Sweep Voltage Attenuator	20:1, 1 kΩ minimum input impedance	Construct if oscilloscope with fixed 50 mV/Div. external sweep input is used
7	RF Power Meter	1.7 to 4.2 GHz	Systron-Donner 4020A
8	Directional Detector	1.7 to 4.2 GHz	Systron-Donner 1026
9	Crystal Detector	1.7 to 4.2 GHz. Type N connector; 0.4 mV/μW	Systron-Donner 306
10	RF Attenuator	10 dB, 1.7 to 4.2 GHz. Type N connectors	Systron-Donner 441A-10
11	RF Attenuator	30 dB, 1.7 to 4.2 GHz. Type N connectors	Systron-Donner 441A-30
12	RF Cable	50 Ω; Type N connectors, 1.7 to 4.2 GHz	Systron-Donner 36000-158
13	RF Cable, 24"	50 Ω; BNC to BNC	ITT Pomona 2249-C-24
14	RF Adapter	N Male to N male	Systron-Donner 051-1
15	RF Adapter	BNC Tee	UG-274A/U
16	Feedthrough Termination	50 Ω	Tektronix 011-0049-01
17	Patch Cable, 24"	Dual Banana Plug to BNC	H.H. Smith 1584-24

**Equipment having equivalent characteristics may be substituted*

4-2.2.2 DIRECTIONAL DETECTOR. If the specified directional detector is not available, an appropriate high-directivity coaxial coupler can be substituted. The coupling factor of the unit should be 13 decibels, and the coupled output must be fitted with a crystal detector rated for the same frequency range. The combined flatness error of the directional coupler and crystal detector should not exceed plus or minus one-half decibel over the 1.7 to 4.2 gigahertz frequency range.

4-2.3 Initial Setup

4-2.3.1 DESCRIPTION. Various controls are preset to desired positions to facilitate subsequent measurements. Connect the equipment and set controls as described below. Do not apply power at this time. All mainframe controls and functions called out in this or subsequent procedures are based upon Model 5000A markings and capabilities. If a mainframe other than Model 5000A is used, make the appropriate corrections in control names and positions. The mainframe markings and functions are similar enough so that no difficulty should be experienced in the translation.

4-2.3.2 PROCEDURE.

1. Install the RF plug-in and dial scale in accordance with the instructions in Section II; be sure to turn the locking knob cw to secure the 5013-2 in the mainframe.
2. Set the mainframe **F1—START** control to its maximum ccw position.
3. Set the mainframe **F2—STOP** control to its maximum cw position.
4. Set the **MODE** switch to **CW**.
5. Set the 5013-2 **1 KHZ** switch to **OFF**.
6. Set the **LEVELER** switch to **INT**. (Set to **OFF** if 5013-2 is not equipped with Option M2 internal leveler.)
7. Set the **RETRACE** switch to **OFF**.
8. Set the **MARKERS** switch to **OFF**.
9. Set the **RF LEVEL** control to its maximum ccw position.
10. Set the mainframe **VERNIER** control to **0.0** (maximum ccw).
11. Turn on the mainframe power switch, then allow the units to warm up for 5 to 10 minutes.

4-2.4 Frequency Accuracy

4-2.4.1 DESCRIPTION. The RF output frequency is measured to ensure that the indicated and actual output frequencies are coincident within the specified tolerance.

NOTE

In order to obtain meaningful results, the dial accuracy of the mainframe must have been checked, and calibrated if necessary, immediately before beginning this procedure. Refer to the appropriate mainframe instruction manual.

4-2.4.2 PROCEDURE. Frequency accuracy should be checked at an ambient air temperature of +25°C (+77°F). When setting the frequency, take care to view the indicators straight on to eliminate parallax:

1. Using the Type N RF cable and 10-dB attenuator, connect the RF output of the plug-in to the input of the frequency counter as shown in Figure 4-1.

CAUTION

DAMAGE TO THE COUNTER MAY RESULT IF THE ATTENUATOR IS NOT USED.

2. Set the **RF LEVEL** control to **10**.

3. Carefully set the **MARKER 2—Fc** control so that the *RED* indicator is aligned with the 1.7 GHz dial mark on the upper part of the scale.

4. The frequency counter must show 1.7 GHz ±17 MHz.

5. Repeat the test for as many dial marks as you wish to test (testing every 500 MHz is usually sufficient). The frequency tolerance must not exceed ±1% of the indicated frequency at any point (±22 MHz at 2.2 GHz, ±33 MHz at 3.3 GHz, and so on).

6. Connect the digital voltmeter to the mainframe **FREQ VOLT** jack.

7. Select the 10 Vdc range of the DVM.

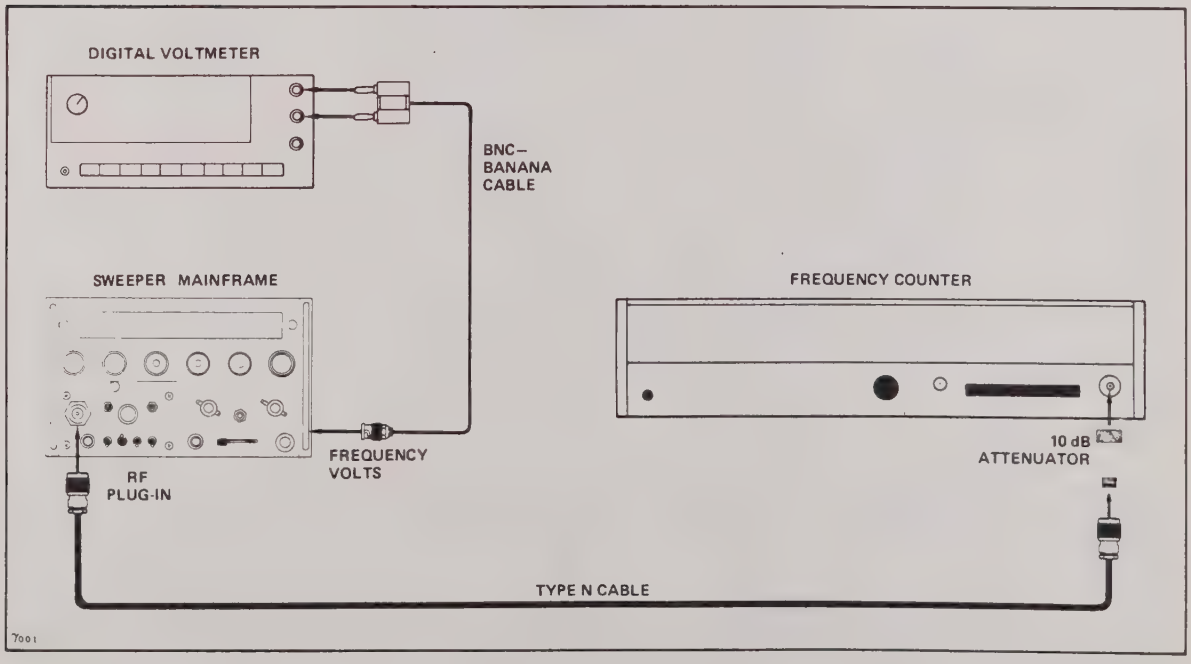


Figure 4-1. Test Setup for Frequency Accuracy Performance Checks

8. Adjust the **MARKER 2—Fc** control for a DVM reading of –0.100 ±0.005 Vdc.

9. Verify the frequency counter shows 1,650 ±25 MHz.

10. Adjust the **VERNIER** control to its maximum cw stop (**10.0**).

11. Verify the frequency is 1,750 ±35 MHz.

12. Rotate the **VERNIER** control to its maximum ccw stop (**0.0**) and lock it in place for the rest of this procedure.

13. Adjust the **MARKER 2—Fc** control for a DVM reading of –2.585 ±0.005 Vdc.

14. Verify the frequency is 2,309 ±25 MHz.

15. Adjust the **MARKER 2—Fc** control for a DVM reading of –5.00 ±0.005 Vdc.

16. Verify the frequency is 2,950 ±25 MHz.

17. Adjust the **MARKER 2—Fc** control for a DVM reading of –7.415 ±0.005 Vdc.

18. Verify the frequency is 3,591 ±25 MHz.

19. Adjust the **MARKER 2—Fc** control for a DVM reading of –9.900 ±0.005 Vdc.

20. Verify the frequency is 4,250 ±25 MHz.

4-2.5 Power Output and Internal Leveling Flatness

4-2.5.1 **DESCRIPTION.** The minimum output power over the 1.7 to 4.2 gigahertz range of the 5013-2 is measured in leveled output mode using the internal directional detector. This procedure applies only to Model 5013-2 RF plug-ins equipped with Option M2. (All current production units include Option M2 unless specifically ordered without it.)

4-2.5.2 PROCEDURE.

1. Turn on the RF power meter and allow it to stabilize. The test setup at this time should be as shown in Figure 4-1.

2. Set the **RF LEVEL** control to **10** and the **LEVELER** switch to **INT**.

3. Set the 5000A **SWEEP SECONDS** switch to **MANUAL SCAN**.

4. Adjust the **MANUAL SCAN** control to maximum ccw rotation.

5. Set the **F1—START** control so the frequency counter reads 1,700 ±25 MHz.

6. Rotate the **MANUAL SCAN** control to maximum cw rotation.

7. Set the **F2—STOP** control so the counter reads 4,200 ±25 MHz.

8. Return the **MANUAL SCAN** control to maximum ccw and check the frequency reading; reset the **F1—START** control if necessary.

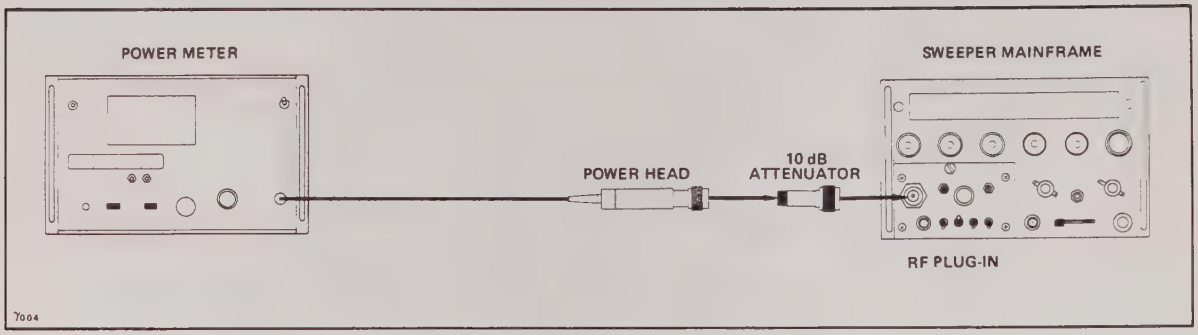


Figure 4-2. Test Setup for Power Output and Internal Leveling Flatness Performance Check

9. Remove the attenuator and counter input cable from the **RF OUT** connector of the 5013-2; connect the leveler and thermistor mount or power head of the power meter as shown in Figure 4-2.

IMPORTANT

The 10-dB attenuator must remain attached to the output connector of the leveler to reduce mismatch losses which might affect measurement accuracy and to avoid possible power meter damage.

10. Set the power meter to its 3 mW (+5 dBm) range (not necessary if Systron-Donner Model 4020A is used).

11. Slowly rotate the **MANUAL SCAN** control through its range; observe the power reading and locate the frequency at which the output amplitude is lowest.

12. Adjust the **RF LEVEL** control for a power level of exactly 10 mW (+10 dBm). Because a 10-dB attenuator was used, the power meter reading will be 1 mW (0 dBm).

13. Slowly vary the **MANUAL SCAN** control over its full range again; check the power meter reading to ensure that the total power level increase over the band does not exceed 1.4 dB.

IMPORTANT

This procedure does not allow for variations in the 10-dB attenuator. The worst-case combination of 5013-2 and attenuator error is $\leqslant \pm 1.6$ dB.

4-2.6 Power Output and External Leveling Flatness

4-2.6.1 DESCRIPTION. The minimum output power over the 1.7 to 4.2 gigahertz range of the 5013-2 is measured in leveled output mode using a matched directional detector. This procedure tests the 5013-2 and the leveling detector simultaneously.

IMPORTANT

The Systron-Donner Model 1026 is made specifically for leveling applications with the 5013-2 and other RF plug-ins in the 1 to 4.2 gigahertz range. Most standard directional couplers are not sufficiently flat to level the output of the 5013-2 as closely as its own binternal directional detector. If the 5013-2 under test has successfully completed the test procedure of Paragraph 4-2.5, and if it responds to the input from an external detector (even though the rated performance specifications may not be met), it should be deemed to have passed this procedure. *If a Model 1026 leveler is used, all performance specifications delineated in this procedure must be met.*

4-2.6.2 PROCEDURE.

1. Turn on the RF power meter and allow it to stabilize. The test setup at this time should be as shown in Figure 4-1.

2. Set the **RF LEVEL** control fully cw.

3. Set the 5000A **SWEEP SECONDS** switch to **MANUAL SCAN**.

4. Adjust the **MANUAL SCAN** control to maximum ccw rotation.

5. Set the **F1—START** control so the frequency counter reads 1,700 ±25 MHz.

6. Rotate the **MANUAL SCAN** control to maximum cw rotation.

7. Set the **F2—STOP** control so the counter reads 4,200 ±25 MHz.

8. Return the **MANUAL SCAN** control to maximum ccw and check the frequency reading; reset the **F1—START** control if necessary.

9. Remove the attenuator and counter input cable from the **RF OUT** connector of the 5013-2; connect the leveler and thermistor mount or power head of the power meter as shown in Figure 4-3.

IMPORTANT

The 10-dB attenuator must remain attached to the output connector of the leveler to reduce mismatch losses which might affect measurement accuracy and to avoid possible power meter damage.

10. Set the **LEVELER** switch to **EXT**.

11. Set the power meter to its 3 mW (+5 dBm) range (not necessary if Systron-Donner Model 4020A is used).

12. Slowly rotate the **MANUAL SCAN** control through its range; observe the power reading and locate the frequency at which the output amplitude is lowest.

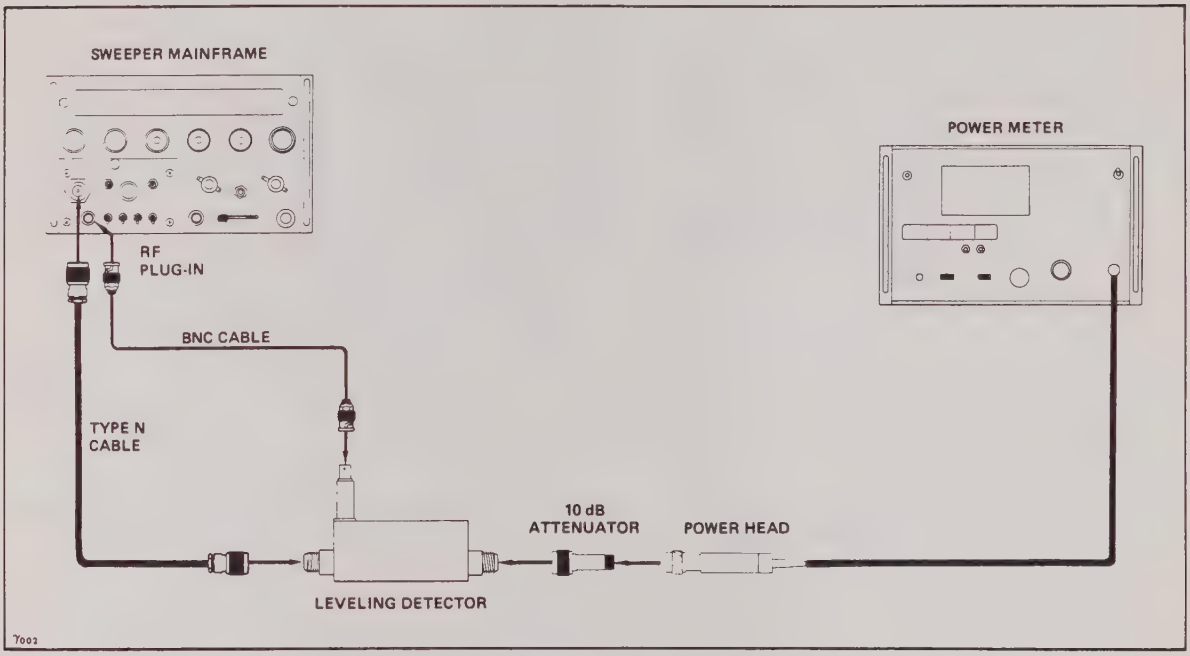


Figure 4-3. Test Setup for Output Power and External Leveling Flatness Performance Checks

13. Adjust the **RF LEVEL** control for a power level of exactly 8 mW (+9 dBm). Because a 10-dB attenuator was used, the power meter reading will be 0.8 mW (–1 dBm).

14. Vary the **MANUAL SCAN** control over its full range again; check the power meter reading to ensure that the total power level increase over the band does not exceed 1.61 dB. This verifies the leveled flatness specification of ⩽ ±0.7 dB for the 5013-2 and the minimum output power specification of 10 mW for the 5013-2 when it is used with an external leveler with the characteristics of the recommended Model 1026.

IMPORTANT

This procedure does not allow for variations in the 10-dB attenuator. The worst-case combination of 5013-2, leveler, and attenuator error is ⩽ ±2.0 B.

4-2.7 Unleveled Power Output and Flatness

4-2.7.1 DESCRIPTION. The peak output power amplitude is measured over the full frequency range of the plug-in to ensure conformance with minimum output power and flatness specifications.

4-2.7.2 PROCEDURE.

1. Connect the test equipment as shown in Figure 4-4.

2. Set the **LEVELING** switch to **OFF**.

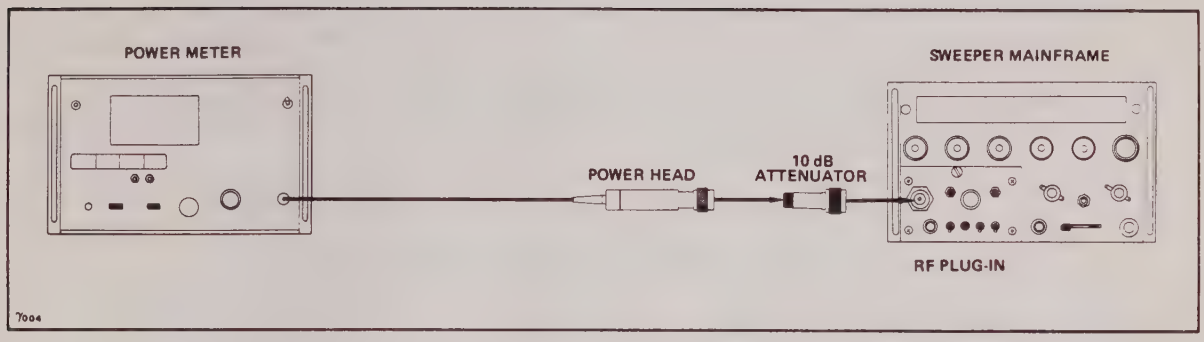


Figure 4-4. Test Setup for Unleveled Power Output and Flatness Performance Check

3. Set the power meter to its 10 mW (+10 dBm) range (not necessary if Systron-Donner Model 4020A is used).

4. Set the **RF LEVEL** control to its maximum cw position; leave it at this position for the rest of the procedure.

5. Slowly vary the **MANUAL SCAN** control over its full range.

6. Set the power meter range switch to the position which allows the best resolution.

7. Check the power meter reading while manually scanning the entire band; note the maximum and minimum amplitudes.

8. Verify that the minimum power is $\geqslant$ 10mW (+10 dBm). Because a 10-dB attenuator was used, the power reading will be $\geqslant$ 1.0 mW (0 dBm).

9. Verify that the maximum power variation (P_{max} - P_{min}) does not exceed 6 dB.

10. Set the **MODE** switch to **CW**.

11. Tune the **MARKER 2—Fc** control over the full range of 1.7 to 4.2 GHz. Verify the maximum power variation (P_{max} – P_{min}) does not exceed 1 dB/100 MHz.

4-3.8 Residual Amplitude Modulation

4-2.8.1 **DESCRIPTION.** The content of unwanted amplitude modulation of the RF output signal is measured to ensure that it is not in excess of the specified value.

4-2.8.2 **PROCEDURE.**

1. Set the **MODE** switch to **WIDE F1—F2**.

2. Set the **SWEEP SECONDS** switch to **MANUAL SCAN**.

3. Set the **F1—START** control so the **F1—START** frequency indicator is at 1.7 GHz.

4. Set the **F2—STOP** control so the **F2—STOP** frequency indicator is at 4.2 GHz.

5. Connect the test equipment as shown in Figure 4-5.

6. Set the oscilloscope bandwidth controls for a lower limit of dc and an upper limit of 100 kHz.

7. Set the oscilloscope time-base controls for an internally-generated free-running trace; use any convenient sweep rate.

8. Set the oscilloscope coupling to "ground" and carefully zero the trace.

9. Set the **LEVELER** and **RETRACE** switches to **OFF**.

10. Turn the **RF LEVEL** control fully cw.

11. Set the vertical sensitivity of the oscilloscope to 100 mV/Division.

12. Set the oscilloscope coupling switch to "dc".

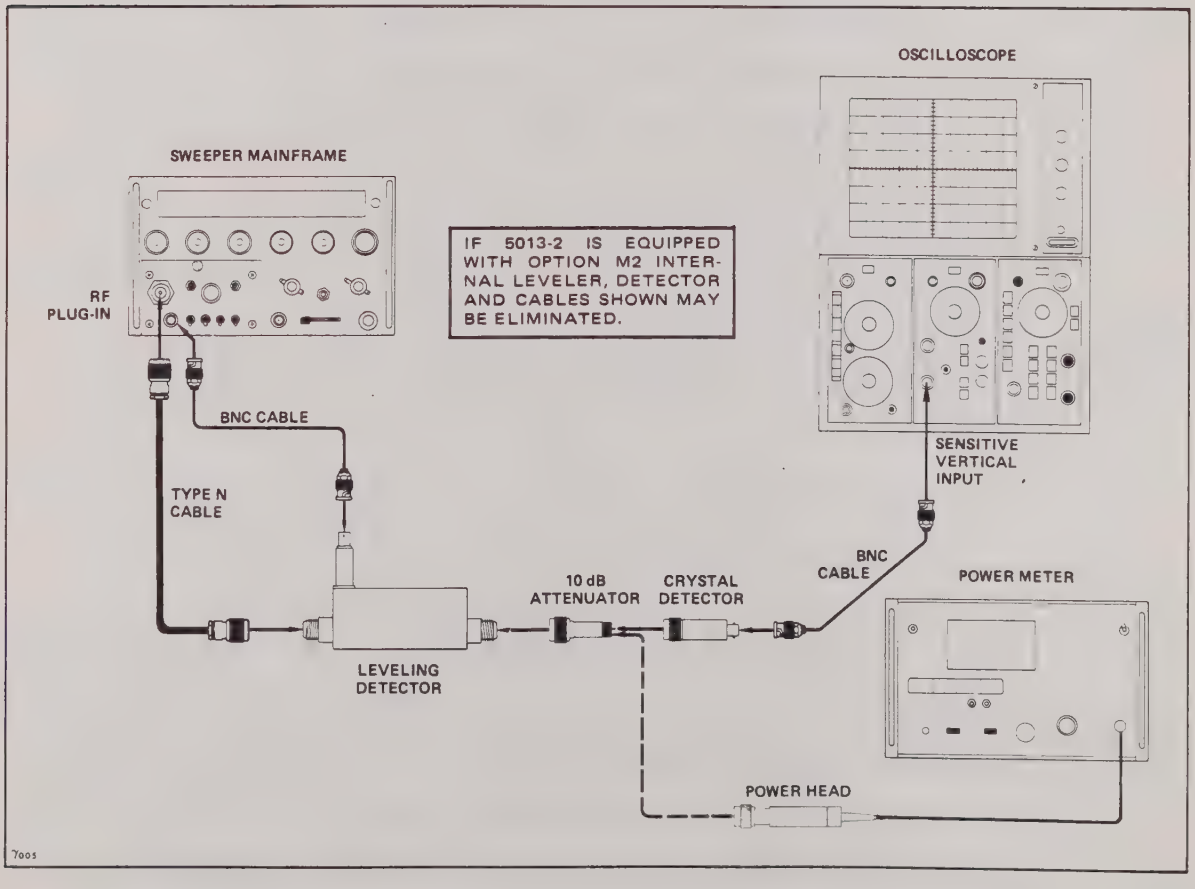


Figure 4-5. Test Setup for Residual Amplitude Modulation Performance Check

13. Rotate the **MANUAL SCAN** control through its range to find the frequency at which the lowest power output occurs. Leave the **MANUAL SCAN** control in this position for the rest of the procedure.

14. Measure and note the dc amplitude of the detected RF output (V_O) at the minimum point.

15. Set the oscilloscope coupling switch to "ac" and the vertical sensitivity to 1 mV/Division.

16. Measure the peak-to-peak voltage of the detected waveform.

17. Divide the amplitude V_O noted in Step *14* by 200; verify that the signal level measured in Step *16* is *less* than this figure ($V_O \div 200 = 46$ dB).

18. Set the **RF LEVEL** control to **0**.

19. Set the **LEVELER** switch to **INT**. If the 5013-2 is not equipped with Option M2 Internal Leveling, use a Model 1026 external leveler and set the switch to **EXT**.

20. Remove the crystal detector from the output of the attenuator.

21. Connect a power meter to the output of the attenuator.

22. Adjust the **RF LEVEL** control for a power meter reading of 1 mW (0 dBm). This sets the output level of the 5013-2 to the rated leveled output amplitude, taking the 10-dB attenuator into account.

23. Without changing the setting of the **RF LEVEL** control, disconnect the power meter from the output of the 10-dB attenuator and reconnect the crystal detector.

24. Set the oscilloscope coupling switch to "ground" and the vertical sensitivity to 50 mV/Division.

25. Carefully establish a zero trace reference, then set the oscilloscope coupling switch to "dc".

26. Set the **RETRACE** switch to **OFF**.

27. Measure and note the dc amplitude (V_O).

28. Set the oscilloscope coupling switch to "ac" and the vertical sensitivity to 1 mV/Division.

29. Measure the peak-to-peak value of the detected waveform.

30. Verify that the leveled mode residual AM index is at least 40 dB by dividing the amplitude V_O (Step *27*) by 100 ($V_O \div 100 = 40$ dB).

4-2.9 Oscillator Pulling and Attenuation

4-2.9.1 DESCRIPTION. The amplitude of frequency change from minimum to maximum output amplitude is measured to ensure that it does not exceed the specified maximum.

4-2.9.2 PROCEDURE.

1. Set the **RF LEVEL** control to **0**.

CAUTION

BE SURE THE INPUT ATTENUATOR OF THE SPECTRUM ANALYZER IS SET TO 30 dB OR GREATER BEFORE PROCEEDING WITH STEP *2*.

2. Connect the equipment as shown in Figure 4-6.
3. Set the spectrum analyzer input attenuator to 30 dB; this may be changed later.
4. Set the **MODE** switch to **CW**.
5. Adjust the **MARKER 2—Fc** control for a frequency of 3 GHz.
6. Set the **LEVELER** switch to **OFF**.
7. Rotate the **RF LEVEL** control fully cw.
8. Tune the spectrum analyzer to 3 GHz; adjust the RF and IF attenuators for a display of the carrier aligned with the logarithmic reference line of the analyzer display.
9. Adjust the spectrum analyzer controls to phase-lock the analyzer to the input signal.
10. Adjust the spectrum analyzer dispersion control(s) for 5 MHz/Division.

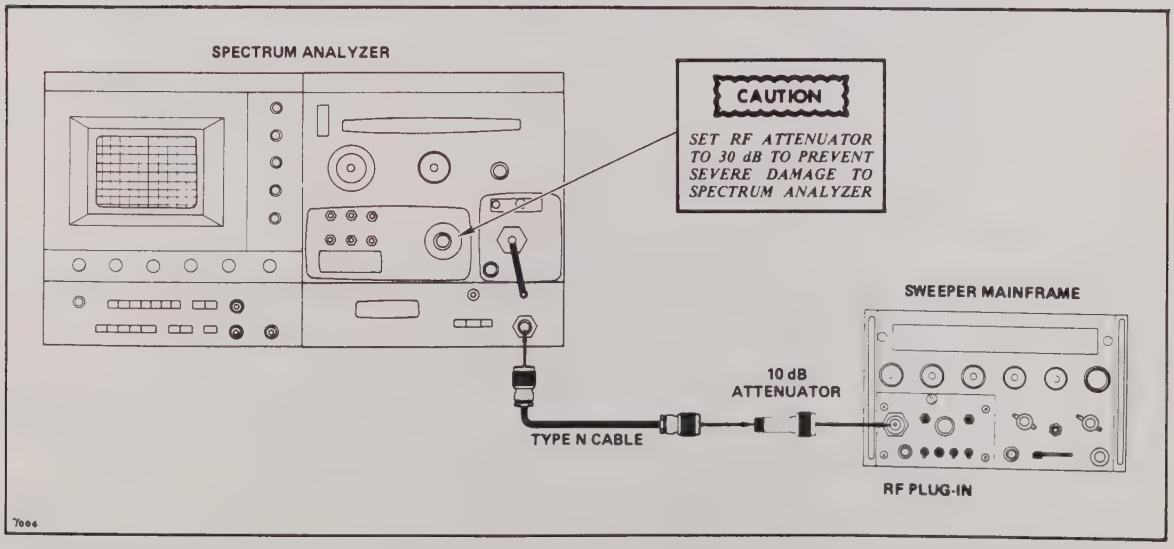


Figure 4-6. Test Setup for Spectrum Analyzer Checks

11. Carefully align the signal display with the center line of the spectrum analyzer horizontal axis.

12. Rotate the **RF LEVEL** control fully ccw.

13. Calculate the change in frequency. Verify the difference in frequency between maximum and minimum output amplitudes does not exceed 3 divisions. This is equivalent to a total change of 15 MHz at 3,000 MHz (±0.25%).

14. Verify the total amplitude change from maximum to minimum is at least 30 dB.

15. Set the **LEVELER** switch to **INT**. If the 5013-2 is not equipped with Option M2 Internal Leveling, use a Model 1026 external leveler and set the switch to **EXT**.

16. Verify the total amplitude change from maximum to minimum is at least 6 dB.

4-2.10 Residual Frequency Modulation

4-2.10.1 DESCRIPTION. The content of unwanted frequency changes in the continuous wave (CW) RF output signal is measured to ensure that it is below the allowable maximum.

4-2.10.2 PROCEDURE.

1. Set the **RF LEVEL** control to **0**.

2. Connect the equipment as shown in Figure 4-2.

3. Set the spectrum analyzer input attenuator to 30 dB; this may be changed later.

4. Set the **MODE** switch to **CW**.

5. Adjust the **MARKER 2—Fc** control for a frequency of 1.7 GHz.

6. Set the **SWEEP SECONDS** switch to **MANUAL SCAN**.

7. Set the **TRIG** switch to **MANUAL**.

8. Set the **RETRACE** switch to **ON**.

9. Set the **LEVELER** switch to **INT**. If the 5013-2 is not equipped with Internal Leveling Option M2, use a Model 1026 external leveler and set the switch to **EXT**.

10. Adjust the **RF LEVEL** control for a power meter reading of 1 mW (0 dBm). This sets the output level of the plug-in to the rated leveled output amplitude, taking the 10 dB attenuator into account.

11. Without changing the setting of the **RF LEVEL** control, disconnect the power meter from the output attenuator.

CAUTION

BE SURE THE INPUT ATTENUATOR OF THE SPECTRUM ANALYZER IS SET TO 30 DB OR GREATER BEFORE PROCEEDING WITH STEP *12*.

12. Connect a cable between the output of the attenuator and the spectrum analyzer RF input. (Refer to Figure 4-6.)

13. Tune the spectrum analyzer to 3 GHz; adjust the RF and IF attenuators for a display of the carrier aligned with the logarithmic reference line of the analyzer display.

14. Adjust the spectrum analyzer controls to phase-lock the analyzer to the input signal.

15. Adjust the spectrum analyzer dispersion control(s) for 20 kHz/Division.

16. Adjust the spectrum analyzer bandwidth control(s) to 30 kHz.

17. Set the sweep speed control(s) for a slow sweep, about 300 ms/division.

18. As the spectrum analyzer CRT trace reaches the log reference level, measure the number of horizontal divisions covered by the trace at the logarithmic reference level; measure several cycles (refer to Figure 4-7).

19. Multiply the number of divisions covered by the trace at the peak level by the dispersion figure. Verify that the residual FM content is less than 20 kHz peak (less than 40 kHz peak-to-peak).

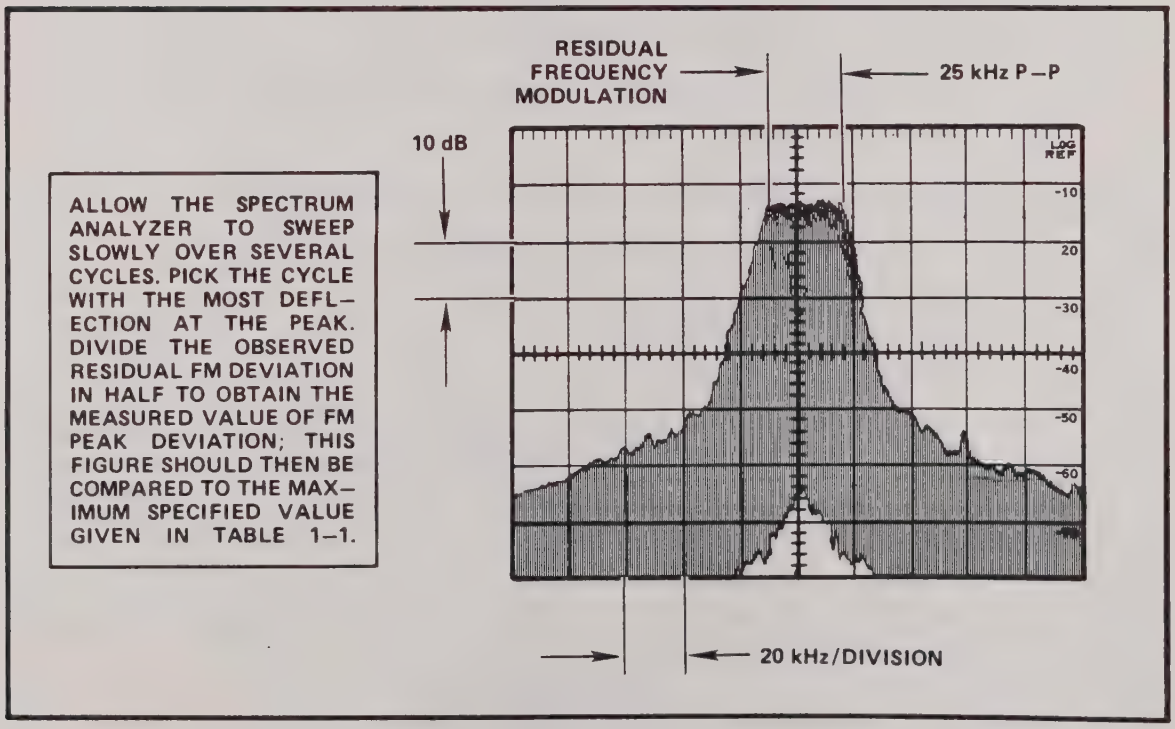

RESIDUAL FREQUENCY MODULATION
25 kHz P–P
10 dB
LOG REF
-10
-20
-30
-40
-50
-60
ALLOW THE SPECTRUM ANALYZER TO SWEEP SLOWLY OVER SEVERAL CYCLES. PICK THE CYCLE WITH THE MOST DEFL–ECTION AT THE PEAK. DIVIDE THE OBSERVED RESIDUAL FM DEVIATION IN HALF TO OBTAIN THE MEASURED VALUE OF FM PEAK DEVIATION; THIS FIGURE SHOULD THEN BE COMPARED TO THE MAX–IMUM SPECIFIED VALUE GIVEN IN TABLE 1–1.
20 kHz/DIVISION

Figure 4-7. Typical Spectrum Analyzer Display of Residual FM

4-2.11 Spurious and Harmonic Content

4-2.11.1 DESCRIPTION. The content of unwanted spurious and harmonic outputs in the RF signal is measured to ensure conformance with the specified maxima.

4-2.11.2 PROCEDURE.

1. Set the **RF LEVEL** control to **0**.
2. Connect the equipment as shown in Figure 4-2.
3. Set the spectrum analyzer input attenuator to 30 dB; this may be changed later.
4. Set the **MODE** switch to **CW**.
5. Adjust the **MARKER 2—Fc** control for a frequency of 1.7 GHz.
6. Set the **SWEEP SECONDS** switch to **MANUAL SCAN**.
7. Set the **TRIG** switch to **MANUAL**.
8. Set the **RETRACE** switch to **ON**.
9. Set the **LEVELER** switch to **INT**. If the 5013-2 is not equipped with Option M2 Internal Leveling, use a Model 1026 external leveler and set the switch to **EXT**.
10. Adjust the **RF LEVEL** control for a power meter reading of 1 mW (0 dBm). This sets the output level of the plug-in to the rated leveled output amplitude, taking the 10-dB attenuator into account.
11. Without changing the setting of the **RF LEVEL** control, disconnect the power meter from the output attenuator.
12. Connect a cable between the output of the attenuator and the spectrum analyzer RF input. (Refer to Figure 4-6.)
13. Tune the spectrum analyzer to 1.7 GHz; adjust the RF and IF attenuators for a display of the carrier aligned with the logarithmic reference line of the analyzer display.

IMPORTANT

Be sure the input signal amplitude is not excessive. Spurious products generated within the spectrum analyzer by excessive input levels will compromise measurement accuracy.

14. Adjust the spectrum analyzer dispersion control(s) for 1 MHz/division.
15. Tune the spectrum analyzer over the frequency range of 1.7 to 4.2 GHz; use the spectrum analyzer manufacturer's recommended signal identification procedures to determine that any observed signal within 60 dB of the log reference level is "real" and not a spurious response generated within the spectrum analyzer. Ignore responses within 1 MHz of the carrier frequency.

16. Verify that any spurious responses within the 1.7 to 4.2 GHz band which are not generated within the spectrum analyzer, and are not within 1 MHz of the carrier frequency, are ⩾ 60 dB down from carrier level.

17. Tune the spectrum analyzer to 1.7 GHz; adjust the RF and IF attenuators for a display of the carrier aligned with the logarithmic reference line of the analyzer display.

18. Tune the spectrum analyzer to 3.4 GHz; verify the level of the second harmonic is ⩾ 20 dB below the log reference level.

19. Tune the spectrum analyzer to 5.1 GHz and verify the level of the third harmonic is ⩾ 20 dB down.

20. Adjust the **MARKER 2—Fc** control for a frequency of 4.2 GHz. Verify the second harmonic at 8.4 GHz and the third harmonic at 12.6 GHz are ⩾ 20 dB below the carrier level.

4-2.12 Internal Amplitude Modulation

4-2.12.1 DESCRIPTION. The frequency and symmetry of the internal square wave generator are tested for conformance to specifications; square wave rise and fall times in the demodulated output are analyzed to ensure leveling loop response is within specification.

4-2.12.2 PROCEDURE.

1. Rotate the **RF LEVEL** control of the 5013-2 to its maximum ccw position.

2. Connect the equipment as shown in Figure 4-8, with the BNC cable connecting the rear-panel **1 KHZ** jack of the mainframe to the low-frequency input of the counter.

3. Set the **LEVELER** switch to **INT**. If the 5013-2 is not equipped with Option M2 Internal Leveling, use a Model 1026 external leveler and set the switch to **EXT**.

4. Set the **1 KHZ** switch to **ON**.

5. Set the mainframe **MODE** switch to **CW**.

6. Adjust the **MARKER 2—Fc** control for a mid-band output frequency, about 3 GHz.

7. Increase the setting of the **RF LEVEL** control to **10**.

8. Rotate the **1 KHZ ADJ** control fully ccw. Verify the frequency is ⩽ 950 Hz.

9. Rotate the **1 KHZ ADJ** control fully cw and verify the frequency is ⩾ 1050 Hz.

10. Set the **1 KHZ ADJ** control to produce an output frequency of 1000 ±5 Hz.

11. Move the 1 kHz input cable from the frequency counter to the "external trigger" input of the oscilloscope delaying time base.

12. Measure the 10% to 90% risetime of the leading edge of the detected 1 kHz square wave. Verify that T_r is ⩽ 10 μs (refer to Figure 4-9).

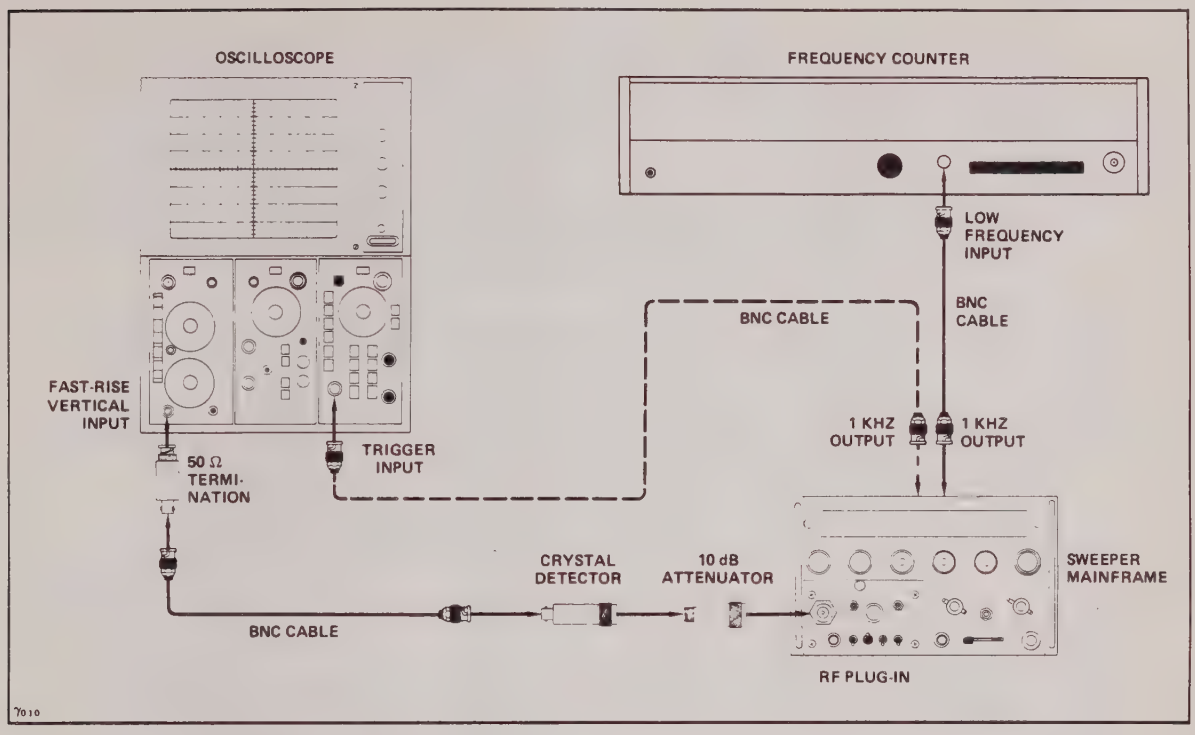


Figure 4-8. Test Setup for Internal Amplitude Modulation Performance Check

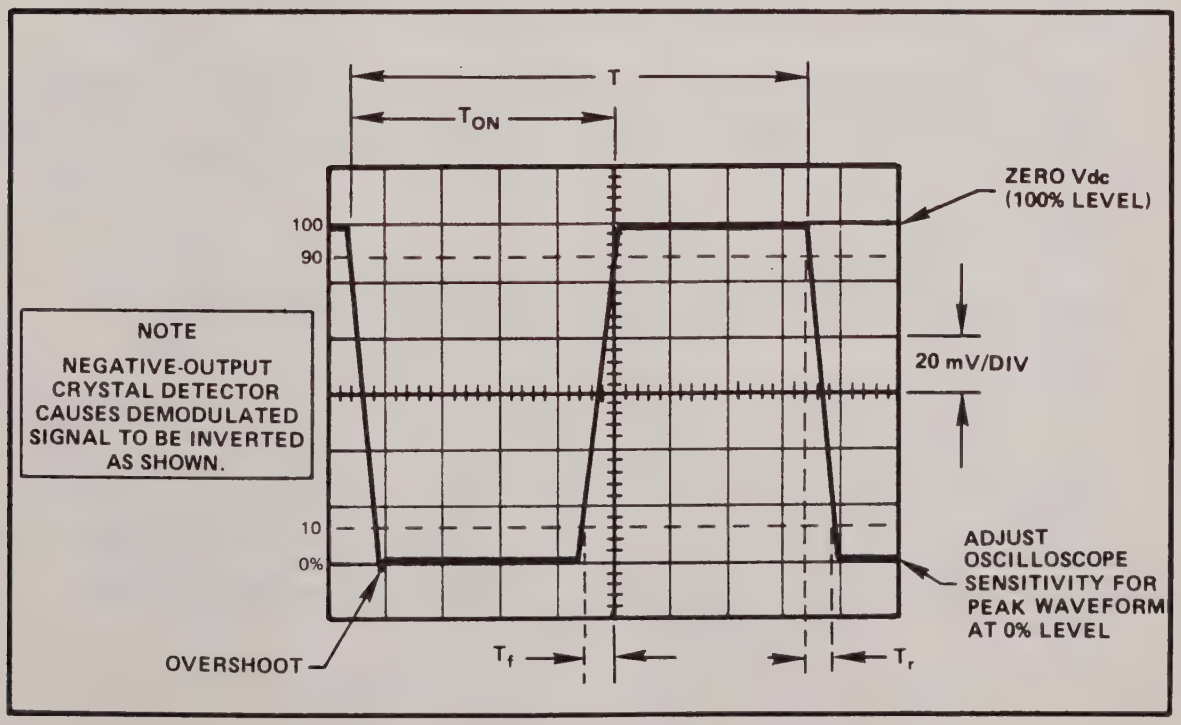


Figure 4-9. Demodulated Square Wave Characteristics

13. Verify that the 90% to 10% fall time of the trailing edge of the waveform is $\leq 10\ \mu s$, as shown in Figure 4-9.

14. Verify that the symmetry error of the detected square wave does not exceed 5%:

    a. Symmetry error (D) is defined as the percentage difference between the ratio of "on" time (T_{on}) less one-half the period time (T) of a single complete square wave cycle to one-half the period time (see Figure 4-9).

    b. Measure the total period time of one detected square wave.

    c. Measure the period of the "on" half of the cycle.

    d. Solve the equation:

$$D = \frac{T_{on} - 0.5\ T}{0.5\ T} \times 100$$

4-3. CALIBRATION

4-3.1 General

This paragraph contains instructions for calibrating the internal circuitry of the Model 5013-2; these procedures are listed in Table 4-3. Recalibration is necessary after parts have been replaced or when periodic performance checks reveal out-of-tolerance conditions.

Several procedures which are not required during normal calibration are also listed in Table 4-3 for the convenience of calibration personnel; these procedures relate to the selection of certain fixed-value components which may be necessary after the replacement of an oscillator or modulator assembly.

4-3.2 Equipment Required for Calibration

Table 4-4 lists items of test equipment required for calibration of the 5013-2 RF Plug-in.

4-3.3 Access to Calibration Components

4-3.3.1 ROUTINE FREQUENCY CALIBRATION. The test technician must have access to the calibration potentiometers mounted on the bottom of Oscillator Driver Board A1 in order to perform routine frequency calibration of the 5013-2. Because of the high currents (up to one ampere) required from the mainframe power supplies, long extension cables which may be satisfactory for trouble isolation and repair should not be used in frequency calibration. Voltage drops on the extension cable wires and connector contacts could affect the calibration accuracy.

Table 4-3. Calibration Procedures

FUNCTION	CONTROL OR COMPONENT	LOCATION	REFERENCE PARAGRAPH
ROUTINE FREQUENCY CALIBRATION NOT INVOLVING COMPONENT REPLACEMENT REQUIRES ADJUSTMENT OF A1R40 AND A1R11 ONLY.			
Oscillator Start Frequency Adjust	R40	A1 Oscillator Driver	4-3.5
Oscillator Stop Frequency Adjust	R11	A1 Oscillator Driver	4-3.5
SELECTION OF FIXED COMPONENT VALUES LISTED BELOW IS NECESSARY AFTER REPLACEMENT OF OSCILLATOR MODULE Y1.			
Oscillator V_c Set	R35, R37, VR9	A1 Oscillator Driver	4-3.7
V_c Programming	R45	A1 Oscillator Driver	4-3.7
SELECTION OF FIXED COMPONENT VALUES LISTED BELOW MAY BE NECESSARY AFTER REPLACEMENT OF OSCILLATOR MODULE Y1 OR A FAULTY A1 BOARD COMPONENT.			
Oscillator Start Frequency Adjust	R41, R43	A1 Oscillator Driver	4-3.8
Oscillator Stop Frequency Adjust	R13	A1 Oscillator Driver	4-3.8
SELECTION OF FIXED COMPONENT VALUES LISTED BELOW MAY BE NECESSARY AFTER REPLACEMENT OF MODULATOR AT1, OSCILLATOR MODULE Y1, OR A FAULTY A2 BOARD COMPONENT.			
Leveled Amplitude Zero	R25, R26	A2 Leveler	4-3.9
Leveled Amplitude Maximum	R14	A2 Leveler	4-3.9
Leveling Loop Stability	C8	A2 Leveler	4-3.9
Leveling Loop Response	C1	A2 Leveler	4-3.9
1 kHz Symmetry	R37	A2 Leveler	4-3.10

Table 4-4. Test Equipment Required for Calibration

ITEM	TYPE OF EQUIPMENT	CHARACTERISTICS	RECOMMENDED MODEL*
1	Sweeper Mainframe	5013-2-compatible	Systron-Donner 5000A
2	Plug-in Extender	5013-2-compatible	Systron-Donner 9202
3	Plug-in Inverter	5013-2-compatible	Systron-Donner 9203
4	Frequency Counter	1.7 to 4.2 GHz	Systron-Donner 6244A
5	Spectrum Analyzer	1.7 to 12.6 GHz; 10 kHz/Div. resolution, 10 dB/Div.	Tektronix 492
6	Digital Voltmeter	Resolution 1 mV on 10 V scale	Systron-Donner 7141A
7	Oscilloscope	High sensitivity with variable bandwidth	Tektronix 5403 mainframe, 5A22 vertical amplifier, 5B42 delaying time base
8	Sweep Voltage Attenuator	20:1, 1 kΩ minimum input impedance	Construct if oscilloscope with fixed 50 mV/Div. external sweep input is used
9	RF Power Meter	1.7 to 4.2 GHz	Systron-Donner 4020A
10	Directional Detector	1.7 to 4.2 GHz	Systron-Donner 1026
11	Crystal Detector	1.7 to 4.2 GHz. Type N connector; 0.4 mV/μW	Systron-Donner 306
12	RF Attenuator	10 dB, 1.7 to 4.2 GHz. Type N connectors	Systron-Donner 441A-10
13	RF Attenuator	30 dB, 1.7 to 4.2 GHz. Type N connectors	Systron-Donner 441A-30
14	RF Cable	50 Ω; Type N connectors, 1.7 to 4.2 GHz	Systron-Donner 36000-158
15	RF Cable, 24"	50 Ω; BNC to BNC	ITT Pomona 2249-C-24
16	RF Adapter	N male to N male	Systron-Donner 051-1
17	RF Adapter	BNC Tee	UG-274A/U
18	Feedthrough Termination	50 Ω, BNC Male and BNC Female	Tektronix 011-0049-01
19	Decade Resistance Box	1 Ω to 1 MΩ ±1%	Heathkit IN-3117 (3 required)
20	Patch Cable, 24"	Dual Banana Plug to BNC	H.H. Smith 1584-24
21	Test Cable, 24"	Dual Banana Plug to miniature test clips	ITT Pomona 3786-C-24 (3 required)

**Equipment having equivalent characteristics may be substituted.*

Model 5000 or 5000A Mainframe. It is not necessary to use an extender to gain access to the 5013-2 frequency calibration controls:

1. Turn off mainframe power.
2. Remove the bottom cover of the mainframe.
3. Lay the mainframe on its left side as shown in Figure 4-10.
4. Do not operate the units for more than fifteen continuous minutes in this configuration.
5. Perform routine calibration detailed in Paragraph 4-3.5.1.

Model 540 or 540B Mainframe with 579 Adapter. Inverter Model 9203 is required to perform routine frequency calibration:

1. Turn off mainframe power.
2. Remove the top cover of the mainframe.
3. Remove the 579 Adapter.
4. Remove the top cover of the 579 Adapter.
5. Install the 579 Adapter in the 540-series mainframe.
6. Connect the 9203 Inverter to the 579 interface connector.

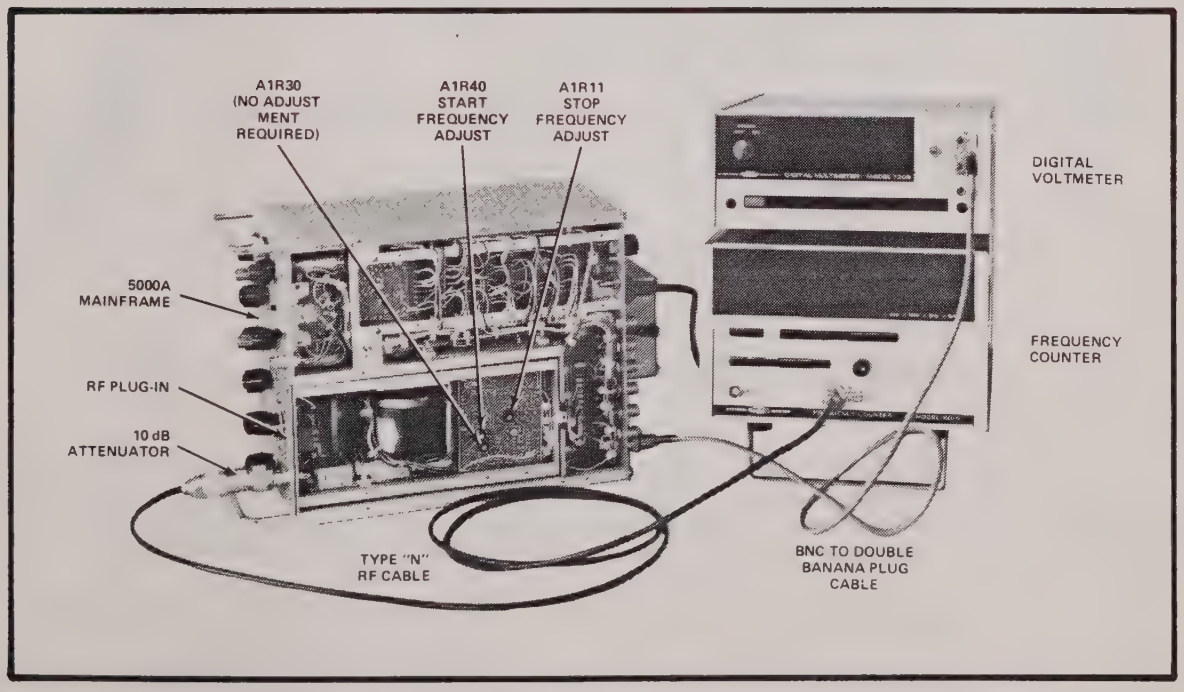


Figure 4-10. Routine Frequency Calibration in 5000-Series Mainframe

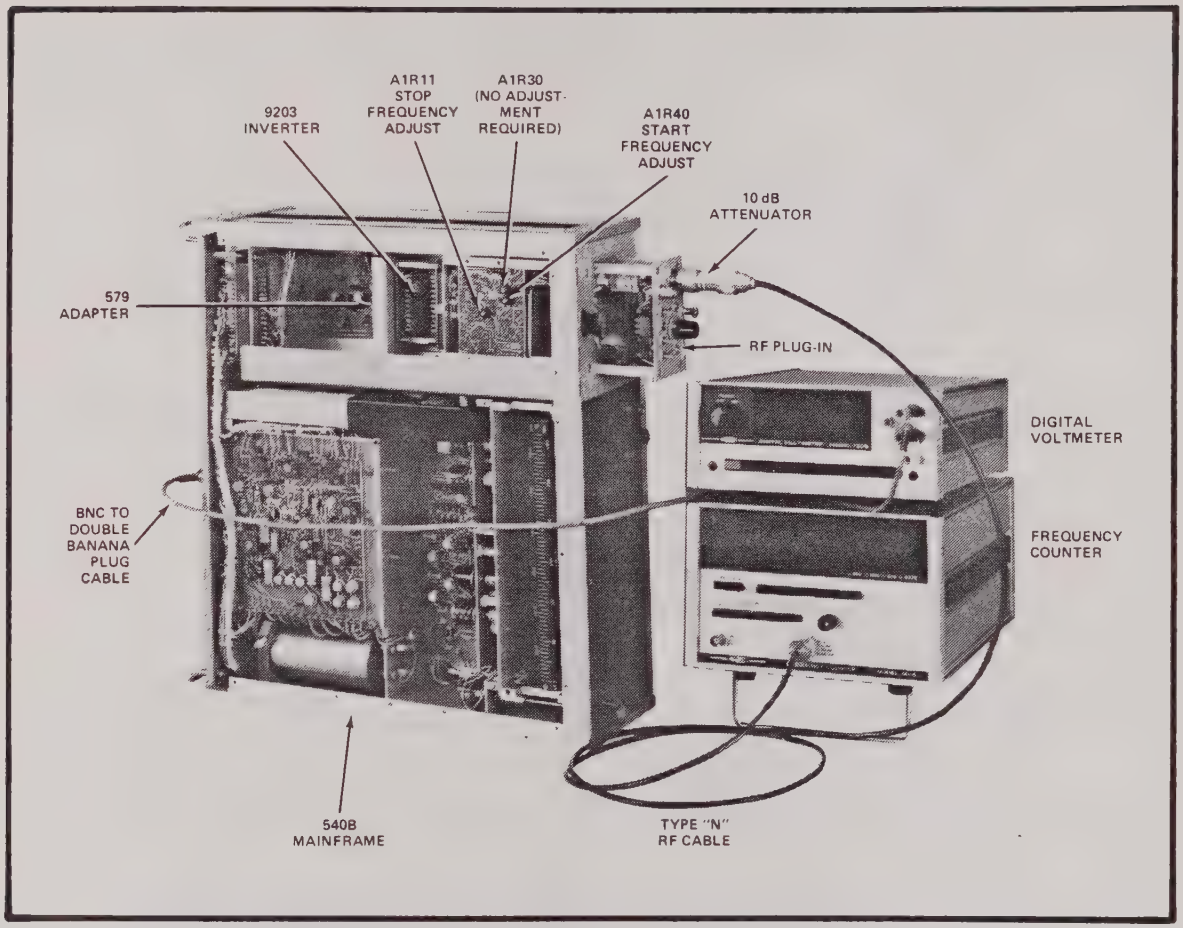


Figure 4-11. Routine Frequency Calibration in 540-Series Mainframe/579 Adapter

7. Connect rear-panel interface connector P20 of the 5013-2 to the mating interface connector of the 9203 Inverter.

8. Lay the mainframe on its left side.

9. Do not operate the units for more than fifteen minutes in this configuration.

10. Perform routine calibration detailed in Paragraph 4-3.5.2.

4-3.3.2 **SELECT-BY-TEST CALIBRATION.** It may be necessary to replace certain fixed-value resistors or capacitors after replacement of critical components. If calibration beyond routine frequency adjustment is required, the 5013-2 should be opened as shown in Figure 4-12 to allow access to the components of printed circuit boards A1 and A2. The disassembly sequence is shown in Figure 4-13.

1. Remove two No. 6-32 x 5/16 in. Oval-head Phillips screws (1) from the top of the front panel.

2. Remove two No. 6-32 x 5/16 in. Flat-head Phillips screws (2) from the top of the rear panel.

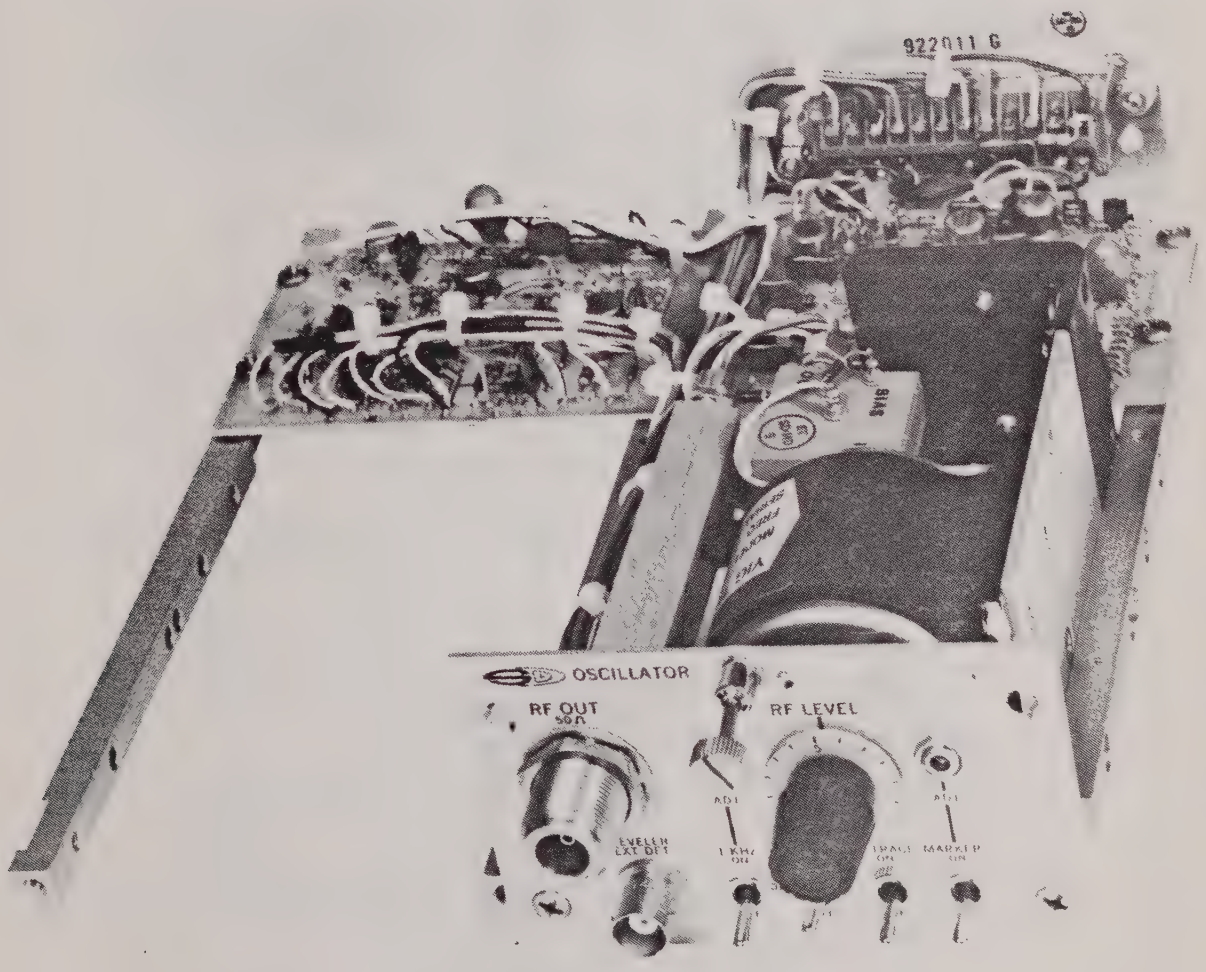


Figure 4-12. Service and Select-by-Test Calibration Configuration

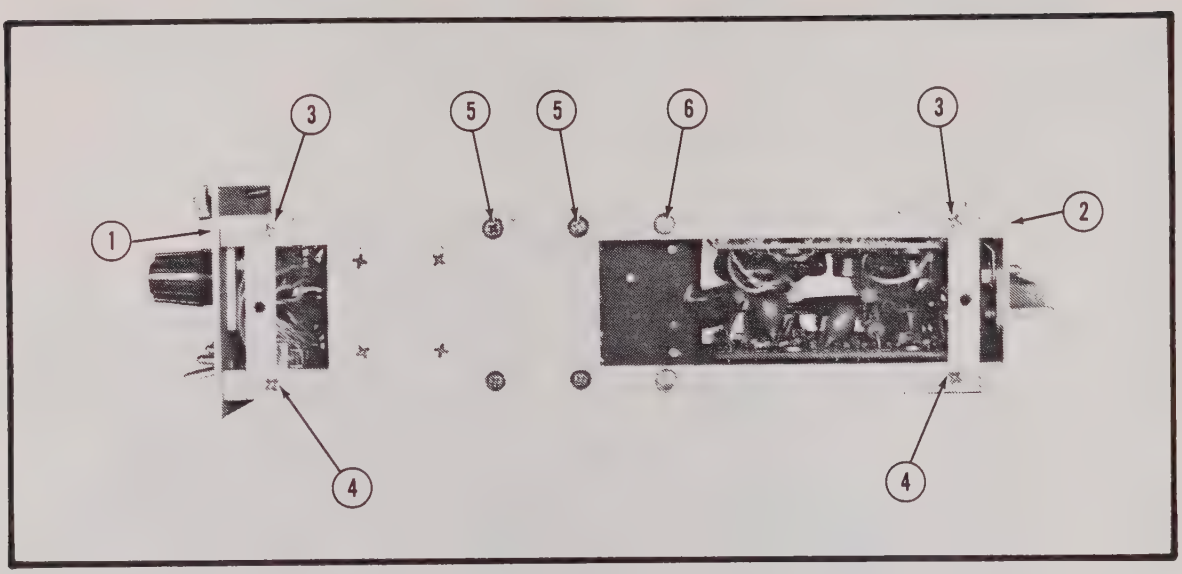


Figure 4-13. Disassembly Sequence for Service and Select-by-Test Calibration

3. Remove two No. 6-32 x 3/16 in. Flat-head Phillips screws (3) from the left top mounting bar.

4. Loosen, but do not remove two Flat-head Phillips screws (4) from the left bottom mounting bar.

5. Remove two No. 4-40 x 5/16 in. pan-head Phillips screws (5) from the left top mounting bar.

6. Remove one No. 6-32 x 5/16 in. Fillister-head Phillips screw (6) from the left top mounting bar.

7. Grasp the top mounting rails and gently pull up to clear the oscillator module and heatsink.

8. Rotate the top mounting rails and A2 board assembly to the right side of the 5013-2. It may be necessary to cut one or more of the nylon cable ties so that the mounting rails and A2 can be fully rotated as shown in Figure 4-12.

CAUTION

USE CARE WHEN CUTTING THESE TIES TO AVOID NICKING OR CUTTING ANY OF THE WIRES. DO NOT STRAIN OR BREAK ANY WIRES SOLDERED TO THE A2 BOARD.

9. Attach the 5013-2 to the interface connector of the 9202 extender. In Model 5000A and some other mainframes, it may be necessary to remove the right-front corner block and handle if any interference is experienced when the 5013-2 is connected.

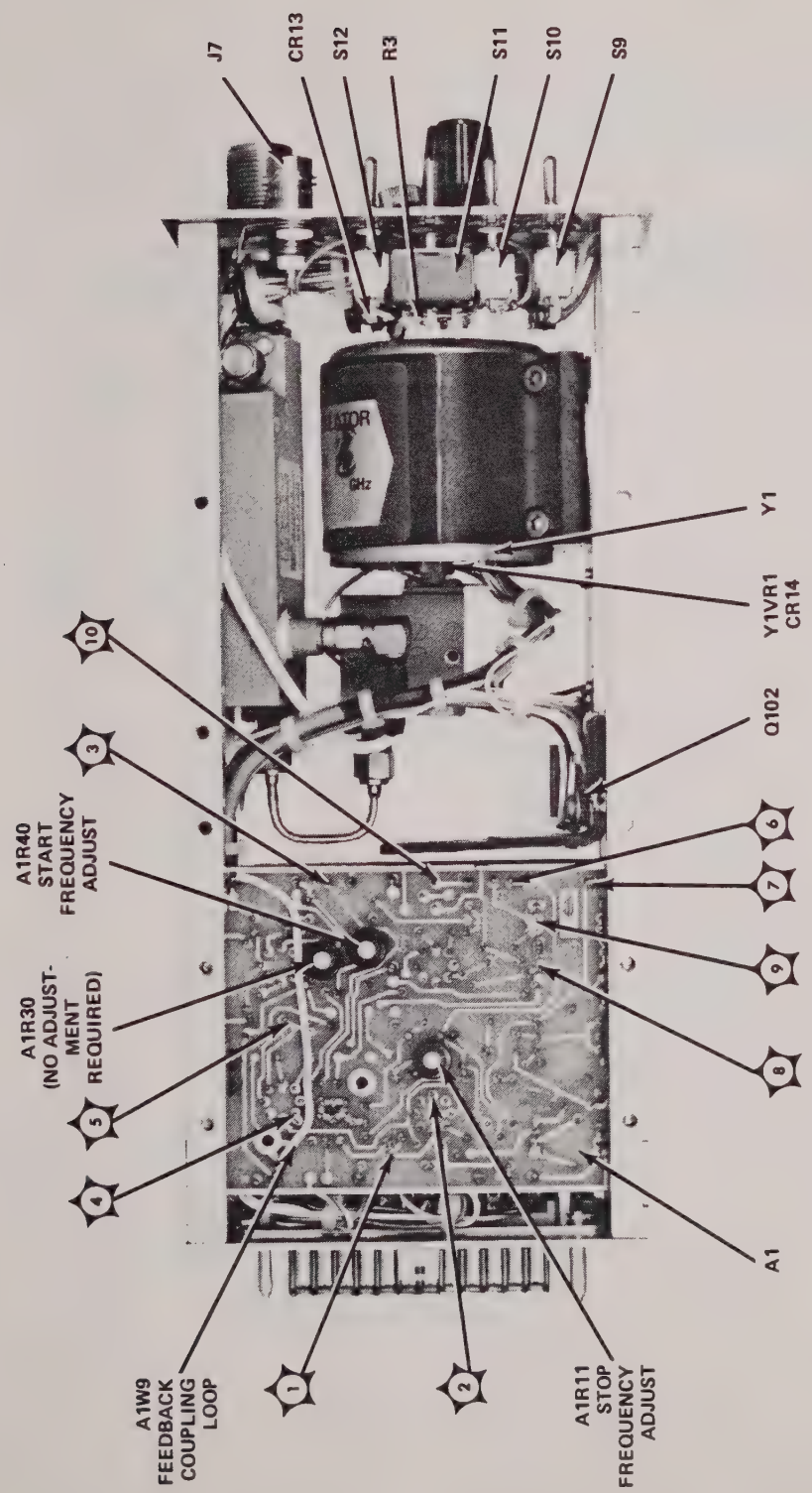


Figure 4-14. Location of Components, Adjustments, and Reference Test Points (Sheet 1 of 2)

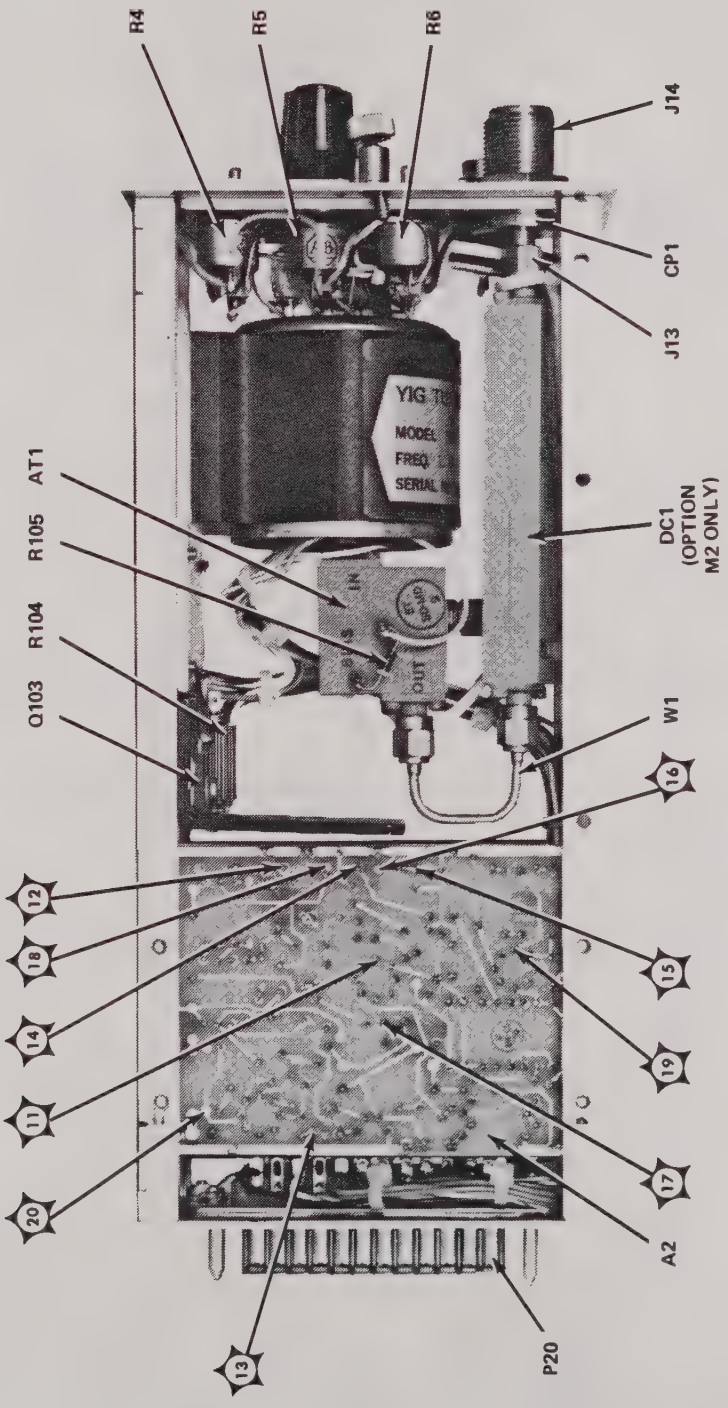


Figure 4-14. Location of Components, Adjustments, and Reference Test Points (Sheet 2 of 2)

4-3.4 Location of Components and Adjustments

As an aid to calibration and repair, the locations of major components and subassemblies and all reference test points and adjustments are shown in Figure 4-14. The reference test points shown are component leads and interconnection eyelets; the 5013-2 does not utilize test point devices. The electrical locations of these reference test points are shown in the schematic diagrams of Oscillator Driver Board A1 (Figure 8-3) and Leveler/AM Board A2 (Figure 9-3).

The adjustment potentiometers are designed to be operated with a small plastic screwdriver. Do not attempt to force a potentiometer if resistance is met, and do not use lacquer, enamel, or any other sealer to hold the potentiometer in place after adjustment.

4-3.5 Routine Frequency Calibration

4-3.5.1 5000 AND 5000A MAINFRAMES.

1. Turn off mainframe power.
2. Connect the test equipment as shown in Figure 4-15.
3. Turn on mainframe power and all test equipment. Allow at least 5 minutes for the equipment to stabilize.
4. Set the mainframe **MODE** switch to **CW**.
5. Set the 5013-2 **1 KHZ** switch to **OFF**.

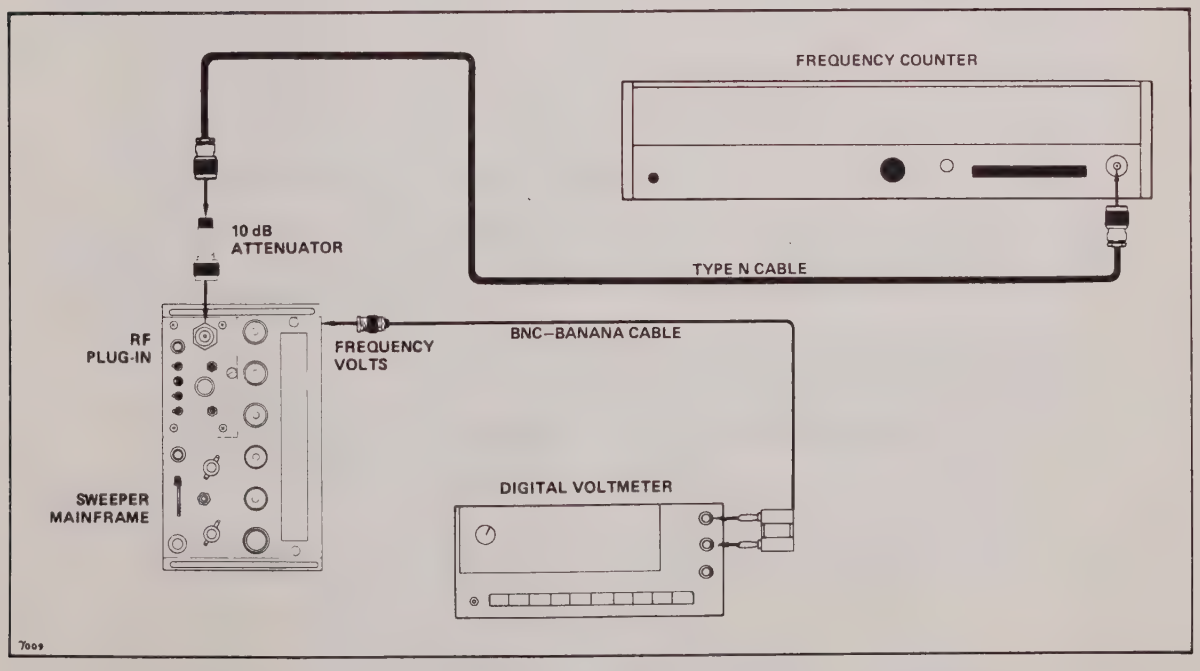


Figure 4-15. Test Setup for Frequency Calibration in 5000-Series Mainframe

6. Set the 5013-2 **LEVELER** switch to **OFF** and the **RF LEVEL** control to **10**.

7. Rotate the **VERNIER** control fully ccw to **0.0**.

8. Adjust the **MARKER 2—Fc** control for a digital voltmeter reading of –0.100 ±0.001 Vdc.

9. Adjust *A1R40 START FREQUENCY ADJUST* (Figures 4-10 and 4-14) for a counter reading of 1,650 ±13 MHz.

10. Adjust the **MARKER 2—Fc** control for a DVM reading of –9.900 ±0.001 Vdc.

11. Adjust *A1R11 STOP FREQUENCY ADJUST* (Figures 4-10 and 4-14) for a counter reading of 4,250 ±13 MHz.

12. Repeat Steps *8* through *11*.

NOTE

No adjustment of potentiometer A2R30 is required.

4-3.5.2 **540 AND 540B MAINFRAMES/579 ADAPTER.**

1. Turn off mainframe power.

2. Connect the test equipment as shown in Figure 4-16.

3. Turn on mainframe power and all test equipment. Allow at least 5 minutes for the equipment to stabilize.

4. Set the 5013-2 **1 KHZ** switch to **OFF**.

5. Set the 5013-2 **LEVELER** switch to **OFF** and the **RF LEVEL** control to **10**.

6. Depress and latch the **CW MODULATION MODE** pushbutton.

7. Depress and latch the mainframe **CW SWEEP MODE** pushbutton.

8. Adjust the **Fc/CW** control for a digital voltmeter reading of –0.100 ±0.001 Vdc.

9. Adjust *A1R40 START FREQUENCY ADJUST* (Figures 4-11 and 4-14) for a counter reading of 1,650 ±13 MHz.

10. Adjust the **Fc/CW** control for a DVM reading of –9.900 ±0.001 Vdc.

11. Adjust *A1R11 STOP FREQUENCY ADJUST* (Figures 4-11 and 4-14) for a counter reading of 4,250 ±13 MHz.

12. Repeat Steps *8* through *11*.

NOTE

No adjustment of potentiometer A2R30 is required.

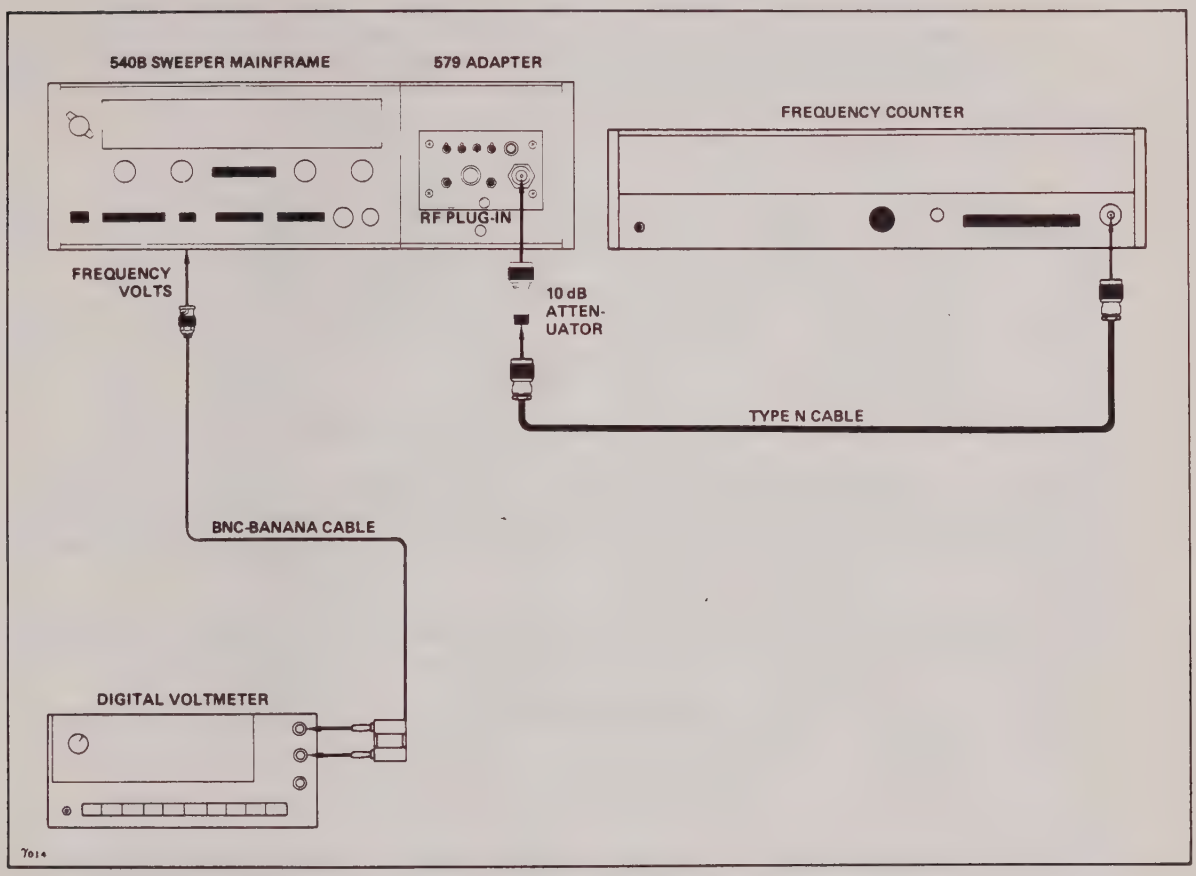


Figure 4-16. Test Setup for Frequency Calibration in 540-Series Mainframe/579 Adapter

4-3.6 General Procedure for Selection of Component Values

Paragraphs 4-3.7 through 4-3.10, following, contain test procedures which require the selection of fixed-value components to accomplish a particular calibration goal. These procedures may be completed for easily if simple practices are followed:

1. When a calibration resistor is removed and replaced with a resistance substitution box, it is generally best to cut the fixed resistor out of the circuit next to the body of the resistor. Use the resistor leads as connecting points for test leads from the resistance substitution box. This will avoid stressing the printed circuit board material and traces with repeated soldering/desoldering operations.

2. When determining resistance value with a decade box or resistance substitution box, always set the decade box value to a standard resistance value (e.g., 47 kΩ, 62 kΩ, etc.). Do not cause yourself unnecessary trouble by calibrating to unavailable component values (e.g., 64 kΩ, 46 kΩ, etc.).

3. Where two select-by-test calibration resistors are wired in parallel, one is used as a "trimming" value for the other. It is expected that one of the resistors will be set to a

relatively low value (in terms of the other resistor) and the parallel resistance will be relatively high in value. Again, only standard resistance values should be used in this situation, although the resulting resistance value in the circuit of the two components will probably not be a standard value.

4-3.7 Oscillator Voltage Setting

4-3.7.1 **DESCRIPTION.** It may be necessary to recalibrate the level of the power source for the oscillator module under any of the following circumstances:

1. Following replacement of a defective oscillator module.
2. Following replacement of Q102, A1U7, A1VR7, or other components in the circuitry around A1U7.
3. If the harmonic content of the RF output exceeds the specified maximum.

A replacement oscillator will require *programming* of the operating voltage (V_C) to obtain optimum performance over the full frequency range of the 5013-2. The test data sheet supplied with the oscillator will specify two voltages; the lower voltage is the optimum V_C at 1.65 gigahertz; the higher voltage is the V_C at 4.25 gigahertz.

4-3.7.2 **PROCEDURE.** If the test data sheet does not specifically state otherwise, V_C should be set for +10.0 ±0.070 Vdc at 1.65 gigahertz and +15.0 ±0.070 Vdc at 1.65 gigahertz.

1. Put the 5013-2 in the *service/select-by-test calibration* configuration (refer to Paragraph 4-3.3.2).
2. Disconnect the white/green wire from the $+V_C$ terminal of oscillator module Y1.
3. Remove resistor A1R35 (Figure 4-17) and connect a resistance decade box in its place. Set the resistance value to 20 kΩ initially.
4. Remove resistor A1R37 (Figure 4-17) and connect a second resistance decade box in its place. Set the resistance value to 270 kΩ initially.
5. Remove resistor A1R45 (Figure 4-17) and connect the third resistance decade box in its place. Set the resistance value to 39 kΩ initially.
6. Connect the positive test lead from the DVM to the white/green wire removed from the oscillator in Step 2.
7. Connect the negative DVM test lead to the chassis of the 5013-2.
8. Install the Model 9202 Extender in the mainframe.
9. Mount the 5013-2 to the 9202; support the front of the 5013-2 with non-conductive material.
10. Adjust the mainframe **F1—START** control for 1.65 GHz and the **F2—STOP** control for 4.25 GHz.
11. Select Wide F1—F2 Sweep mode.

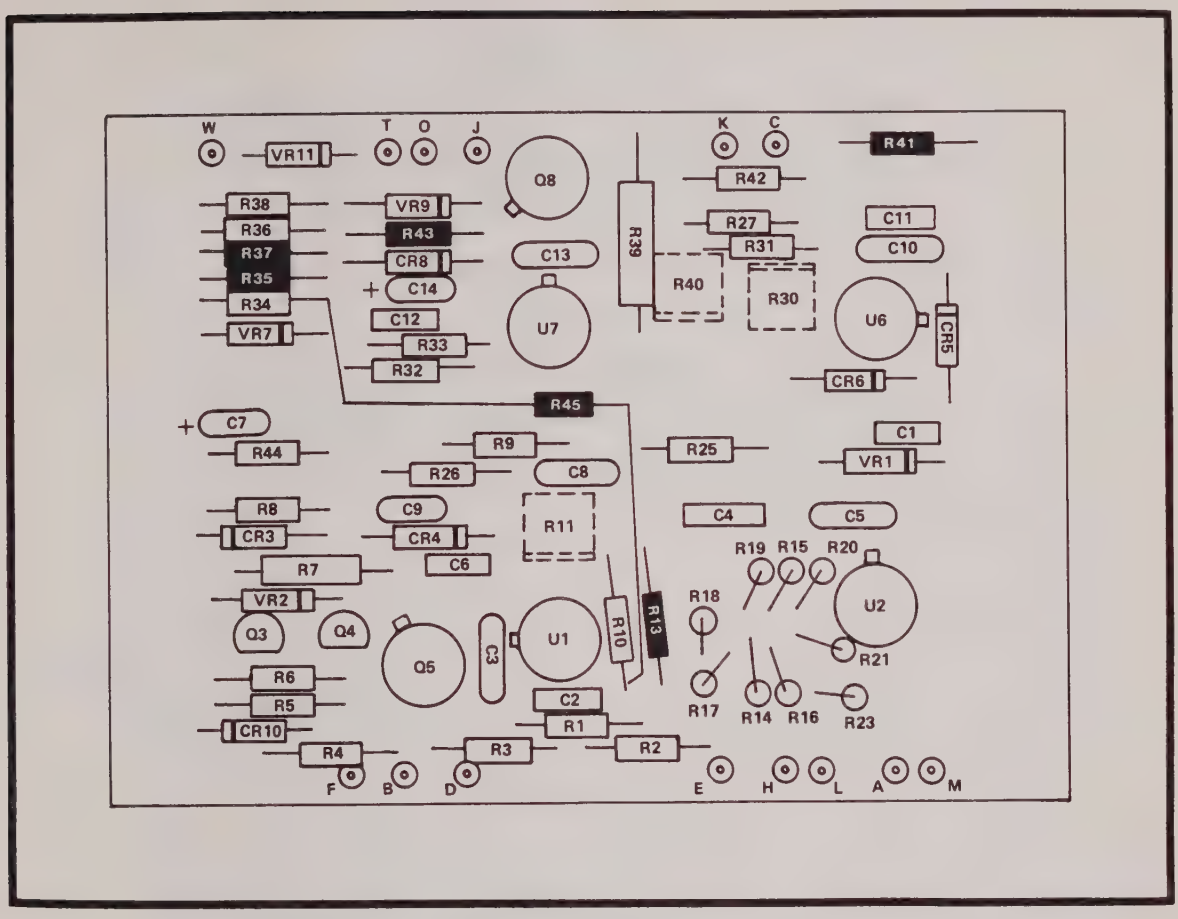


Figure 4-17. A1 Board Calibration Component Location

12. Select Manual Scan mode.

13. Turn the mainframe power on and allow the equipment to warm up for ≈ 5 minutes.

14. Preset the 5013-2 frequency calibration adjustments:

    a. A1R40 center of rotation

    b. A1R11 center of rotation

15. Connect the equipment as shown in Figure 4-18.

IMPORTANT

When the 5013-2 is mounted on an extender, it does not benefit from the air flow (convection cooling) within or the heat-sinking properties (conduction cooling) of the mainframe. To prevent unnecessary shortening of usable life or possible damage to the oscillator module, a method of cooling must be provided if the 5013-2 is operated outside the mainframe for more than thirty minutes at a time.

CAUTION

RE-CHECK THE TEST SETUP AND ALL CONNECTIONS BEFORE TURNING ON MAINFRAME POWER. EXCESSIVE OPERATING VOLTAGE OR IMPROPER TEST CONNECTIONS COULD DAMAGE OSCILLATOR, PLUG-IN, OR MAINFRAME CIRCUITRY.

WARNING

WORK WITH CAUTION AROUND THE EXPOSED TERMINALS OF INTERFACE CONNECTOR P20. PIN 2 OF THIS CONNECTOR CARRIES A POTENTIALLY LETHAL VOLTAGE OF +250 Vdc.

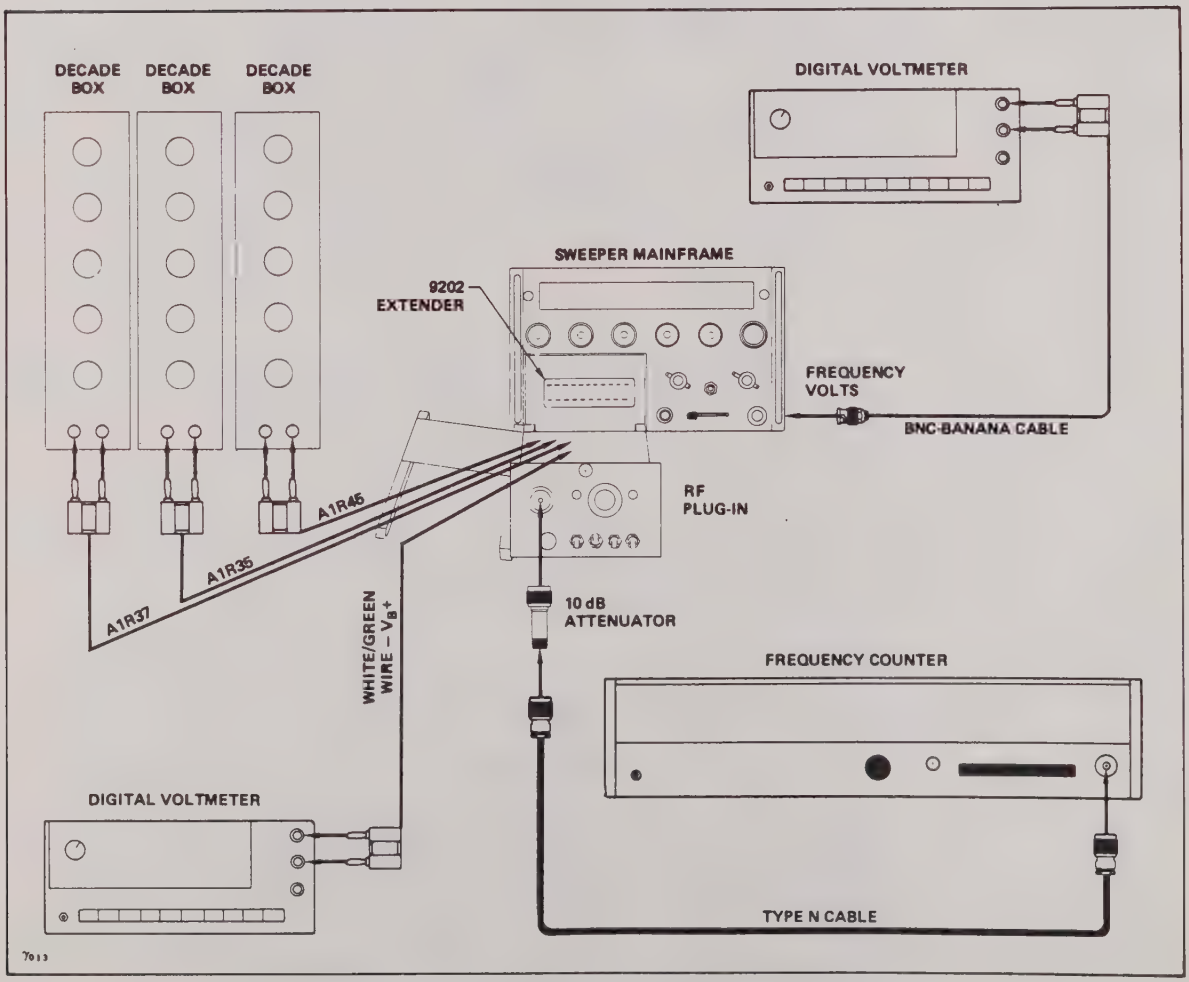


Figure 4-18. Test Setup for Oscillator V_C Setting

16. Turn the mainframe power on and allow the equipment to warm up for ≈ 5 minutes.

17. Set the **MANUAL SCAN** control fully ccw.

18. Select values for A1R35 and A1R37 which yield the specified voltage at 1.65 GHz.

19. Adjust the **MANUAL SCAN** control fully cw.

20. Select a value for A1R45 which yields the specified voltage at 4.25 GHz.

21. Re-adjust the values of A1R35 and/or A1R37 if necessary to satisfy the requirements of Steps *18* through *20*.

22. Momentarily connect a shorting jumper across A1VR9; remove the short circuit and verify the V_C is < 1 Vdc.

23. Turn mainframe power off for ≈ 15 seconds, then turn it back on. Verify V_C is as set in Step *20*.

24. Turn off mainframe power.

25. Solder the white/green wire to the $+V_C$ terminal of oscillator Y1.

26. Pick the standard resistor values closest to the decade box resistance settings for A1R35 and A1R37. The resistors must have the following characteristics:

    a. Metal film construction

    b. Tolerance of ±2%

    c. Wattage rating of ¼ W

    d. Temperature coefficient of ±9 PPM or less

27. Tack-solder these resistors to the A1 board.

28. Pick the standard resistor value closest to the decade box setting determined for A1R45 and tack-solder it in place.

29. Select the mainframe's CW mode.

30. Turn mainframe power on.

31. Set the **CW** control for a DVM reading of –0.100 ±0.001 Vdc.

32. Adjust A1R40 for a counter reading of 1,650 ±25 MHz.

33. Verify the voltage at $+V_C$ is the specified value ±0.070 Vdc.

34. Set the **CW** control for a DVM reading of –9.900 ±0.001 Vdc.

35. Adjust A1R11 for a counter reading of 4,250 ±25 MHz.

36. Verify the voltage at $+V_C$ is the specified value ±0.070 Vdc.

37. Verify the voltage at the **+15V** terminal of oscillator Y1 is +14.9 ±0.5 Vdc. Replace Zener diode CR14 (mounted to Y1) if this voltage is not as specified.

NOTE

If it is not possible to adjust A1R40 and A1R11 as described, perform the calibration procedure of Paragraph 4-3.8 before proceeding with Step *38* of this procedure.

38. Repeat Steps *30* through *34*.

39. Turn off mainframe power.

40. Permanently solder the selected resistors in place.

4-3.8 Frequency Range Resistor Selection

It may be necessary to recalibrate the adjustment range of frequency-control potentiometer A1R40 or A1R11 under any of the following circumstances:

1. Following replacement of a defective oscillator module

2. Following replacement of Q101, A1U1, A1U2, A1Q5, or other components on circuit board A1

3. If the adjustment range of A1R40 or A1R11 is found to be insufficient to allow the calibration procedures of Paragraphs 4-3.5 or 4-3.7 to be performed.

4-3.8.1 INITIAL SETUP.

1. Put the 5013-2 in the *service/select-by-test calibration* configuration (refer to Paragraph 4-3.3.2).

2. Set A1R40 to the physical center of its adjustment range.

3. Set A1R11 to the physical center of its adjustment range.

4. Remove resistor A1R41 and connect a resistance decade box in its place. Set the resistance value to match that of the resistor removed.

5. Remove resistor A1R43 and connect a resistance decade box in its place. Set the resistance value to match that of the resistor removed.

6. Remove resistor A1R13 and connect a resistance decade box in its place. Set the resistance value to match that of the resistor removed.

7. Connect the test equipment as shown in Figure 4-19 (5000 or 5000A mainframe) or 4-20 (540 or 540B mainframe).

8. Install the Model 9202 Extender in the mainframe.

9. Mount the 5013-2 to the 9202; support the front of the 5013-2 with non-conductive material.

10. Select the mainframe or controller's CW sweep mode.

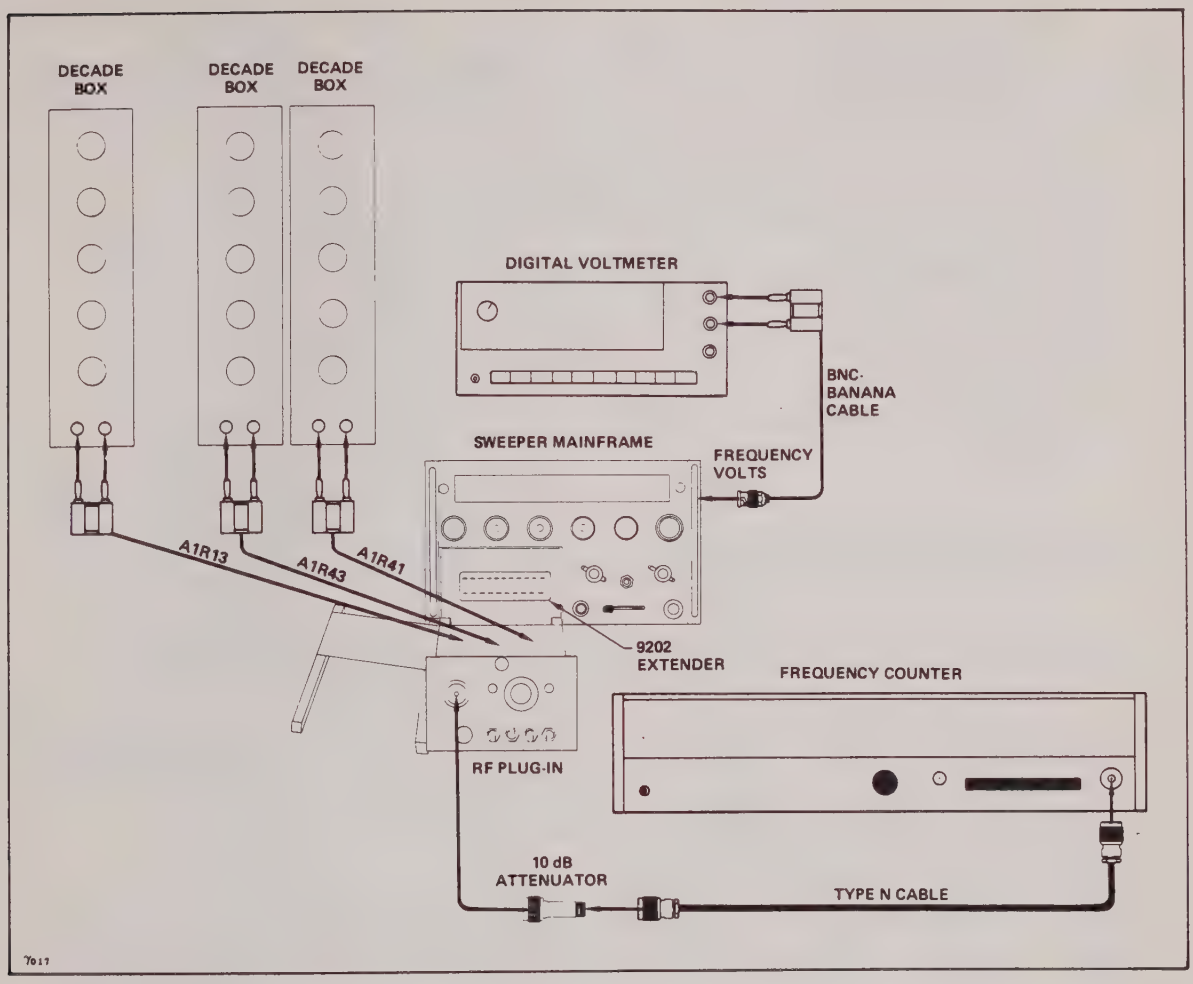


Figure 4-19. Test Setup for Frequency Range Calibration in 5000-Series Mainframe

4-3.8.2 START AND STOP FREQUENCY RANGE CALIBRATION.

1. Turn mainframe power on. Allow ≈ 5 minutes for warmup.
2. Set the **CW** control for a DVM reading of –0.100 ±0.001 Vdc.
3. Select resistance values for A1R41 and A1R43 which produce a counter reading of 1,650 ±25 MHz.
4. Rotate A1R40 throughout its range; the adjustment range should be ≈ ±65 MHz. Select values for A1R41 and A1R43 which allow this adjustment range for A1R40 and result in an output frequency of 1,650 MHz at mid-position.
5. Set the **CW** control for a DVM reading of –9.900 ±0.001 Vdc.
6. Select a resistance value for A1R13 which produces a counter reading of 4,250 ±25 MHz.

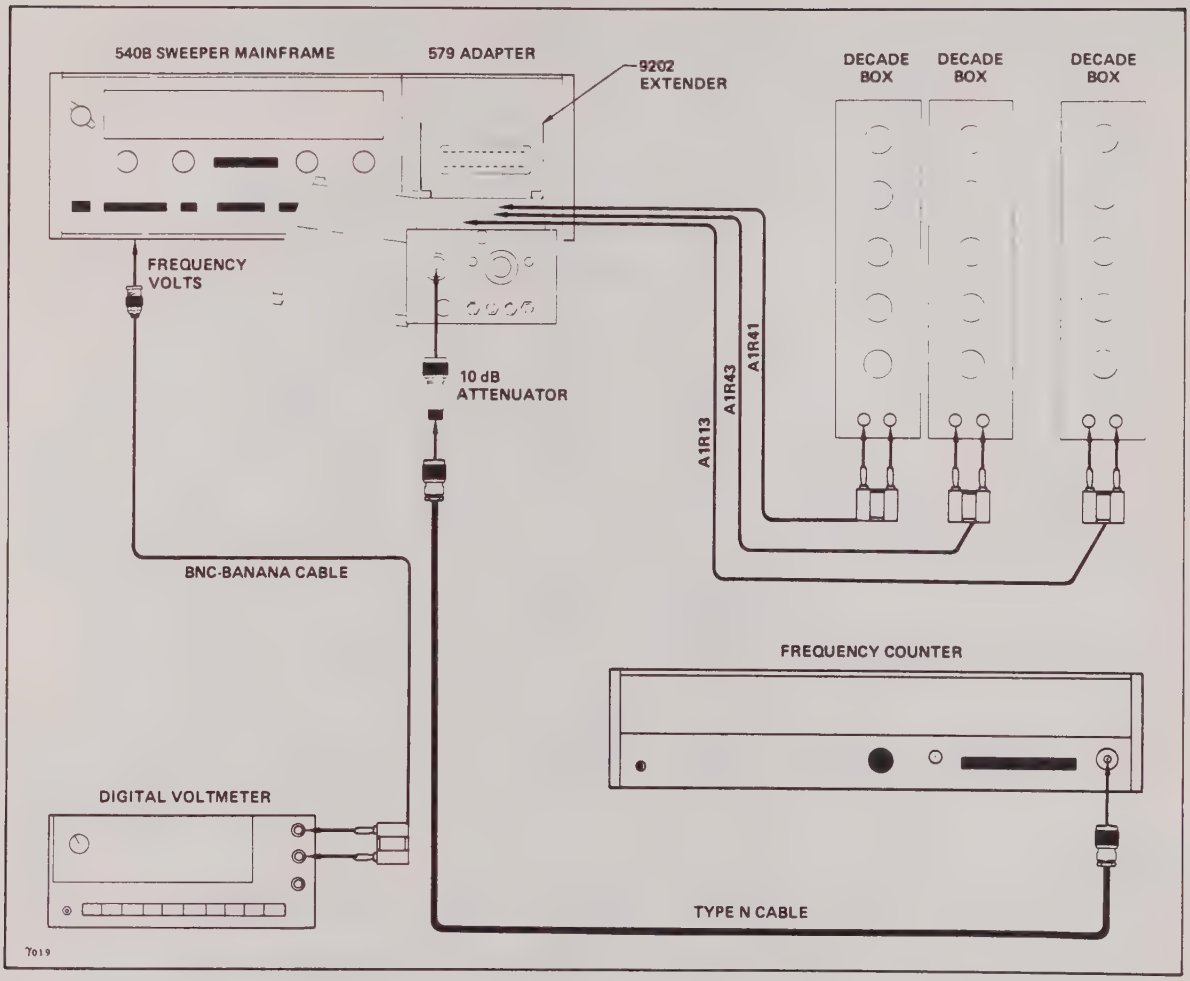


Figure 4-20. Test Setup for Frequency Range Calibration in 540-Series Mainframe/579 Adapter

7. Repeat Steps 2 through 6.

8. Turn off mainframe power and remove the 5013-2.

9. Pick the standard resistor value closest to the decade box resistance settings for A1R41, A1R43, and A1R13. The resistors must have the following characteristics:

   a. Metal film construction

   b. Tolerance of ±2%

   c. Wattage rating of ¼ W

   d. Temperature coefficient of ±9 PPM or less.

10. Permanently solder the selected resistors in place.

4-3.9 Leveling Loop Calibration

It may be necessary to recalibrate the amplitude leveling loop by installation of fixed-value components under any of the following circumstances:

1. Following replacement of a defective oscillator module
2. Following replacement of a defective modulator assembly
3. Following replacement of A2U4, A2Q5, or other components on circuit board A2
4. If the **RF LEVEL** control power dial calibration is found to be incorrect in leveled mode when a matched –10 mV/mW leveler is used
5. If the RF output of the 5013-2 contains spurious oscillations in leveled mode only (refer to Paragraph 4-3.9.2).

4-3.9.1 AMPLITUDE CALIBRATION.

1. Put the 5013-2 in the *service/select-by-test calibration* configuration (refer to Paragraph 4-3.3.2).
2. Remove resistors A2R25 and A2R26 and connect separate resistance decade boxes in their places. Set both decade boxes to 150 kΩ.
3. Remove resistor A2R14 and connect a resistance decade box in its place. Set the decade box to 1 MΩ.
4. Install the Model 9202 Extender in the mainframe.
5. Mount the 5013-2 to the 9202; supporthfront of the 5013-2 with non-conductive material.
6. Turn on mainframe power.
7. Select the mainframe or controller's wide F1—F2 sweep mode.
8. Select the fast sweep mode, 0.01 seconds.
9. Set the mainframe **F1—START** control to 1.65 GHz and the **F2—STOP** control to 4.25 GHz.
10. Connect the equipment as shown in Figure 4-21; do not connect the short cable to the **LEVELER EXT DET** jack yet.
11. Connect the + lead of the DVM to TP12 (Figures 4-14 and 4-22).
12. Connect the – DVM lead to chassis ground.
13. Set and calibrate the oscilloscope controls to accept the 0 to 10 V sweep ramp output of the mainframe for horizontal deflection.
14. Set the 5013-2 **1 KHZ, MARKERS,** and **RETRACE** switches to **OFF**.

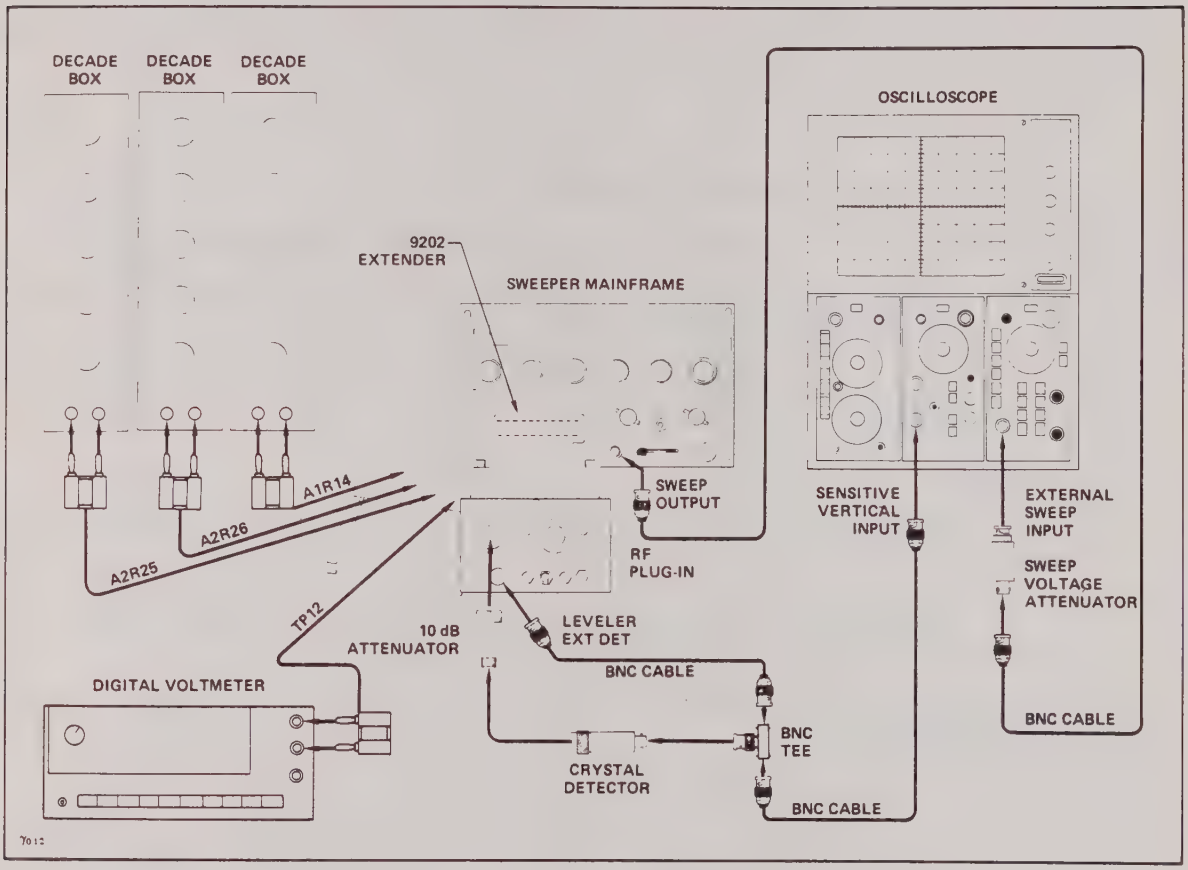


Figure 4-21. Test Setup for Leveling Loop Amplitude Calibration

15. Set the 5013-2 **LEVELER** switch to **EXT**.

16. Set the oscilloscope vertical channel preamplifier for 1 mV/Division. Establish a ground reference line on the oscilloscope trace.

17. Adjust the **RF LEVEL** control for a DVM reading of +30 ±5 mVdc.

18. If the dial is not at the "0" marking, loosen the two Allen-head set screws securing the knob to the shaft of the **RF LEVEL** potentiometer and reposition it.

19. Connect the short BNC cable from the tee adapter at the output of the crystal detector to the **LEVELER EXT DET** jack (see Figure 4-22).

20. Select resistor values for A1R25 and A2R26 which yield an output level of 0.0 mV on the oscilloscope.

21. Check the ground reference level on the oscilloscope and readjust the "position" control if necessary, then repeat Step *20*.

22. Rotate the **RF LEVEL** control so the dial is at **10**.

23. Change the oscilloscope vertical channel sensitivity to 20 mV/Division.

24. Select a resistor value for A2R14 which causes the oscilloscope trace to deflect 100 ±2 mV (5 Divisions ±½ minor Division).

25. Set the **RF LEVEL** control to **0**, then repeat Steps *20* through *24*.

26. Turn off mainframe power and remove the 5013-2.

27. Pick the standard resistor values closest to the decade box settings for A2R14, A2R25, and A2R26. The resistors must have the following characteristics:

    a. Metal film construction

    b. Tolerance of ±2%

    c. Wattage rating of ¼ W

    d. Temperature coefficient of ±9 PPM or less

28. Permanently solder the selected resistors in place.

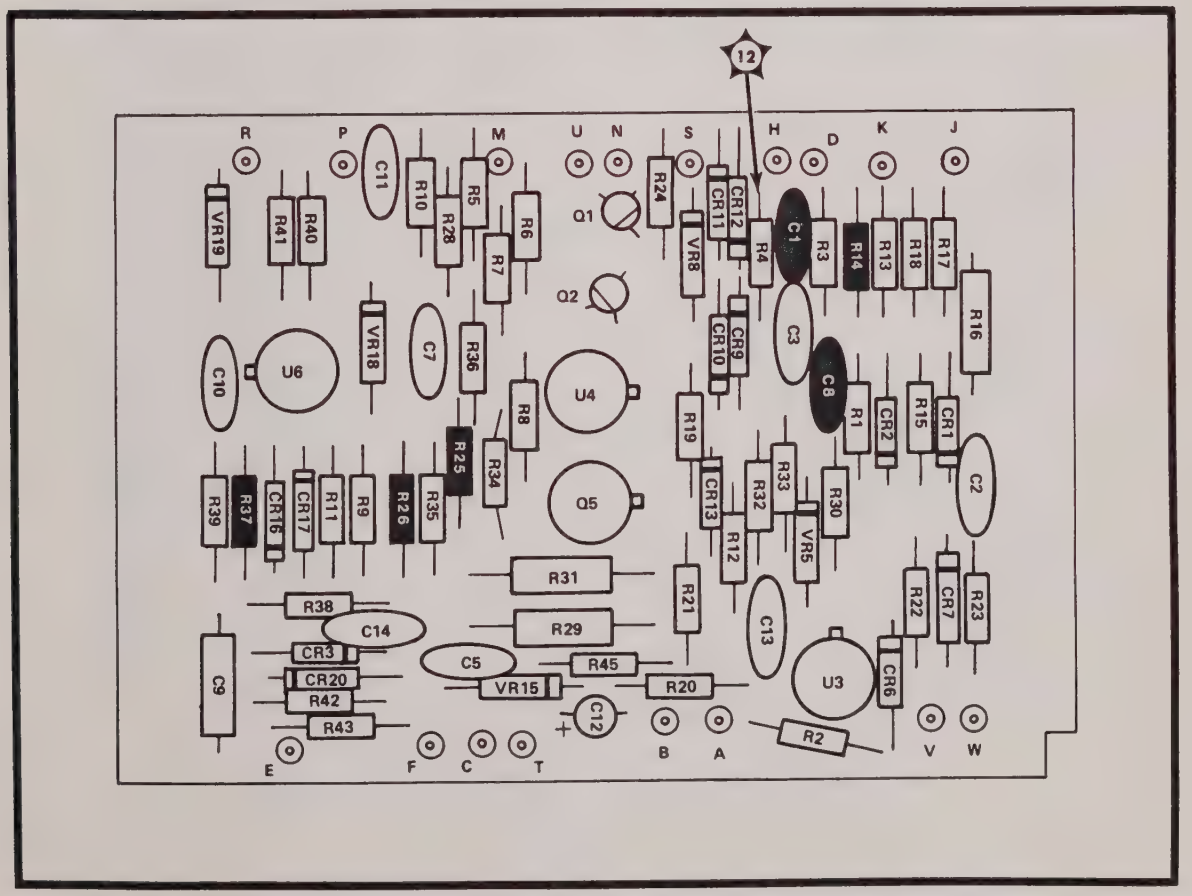


Figure 4-22. A2 Board Calibration Component Location

4-3.9.2 LEVELING LOOP TIME CONSTANT AND STABILITY CALIBRATION.

1. Put the 5013-2 in the *service/select-by-test calibration* configuration (refer to Paragraph 4-3.3.2).
2. Remove capacitors A2C8 and A2C1.
3. Install the Model 9202 Extender in the mainframe.
4. Mount the 5013-2 to the 9202; support the front of the 5013-2 with non-conductive material.
5. Turn on mainframe power.
6. Select the mainframe or controller's wide F1—F2 sweep mode.
7. Select the fast sweep mode, 0.01 seconds.
8. Set the mainframe **F1—START** control to 1.65 GHz and the **F2—STOP** control to 4.25 GHz.
9. Connect the equipment as shown in Figure 4-23; connect the short cable to the **LEVELER EXT DET** jack.

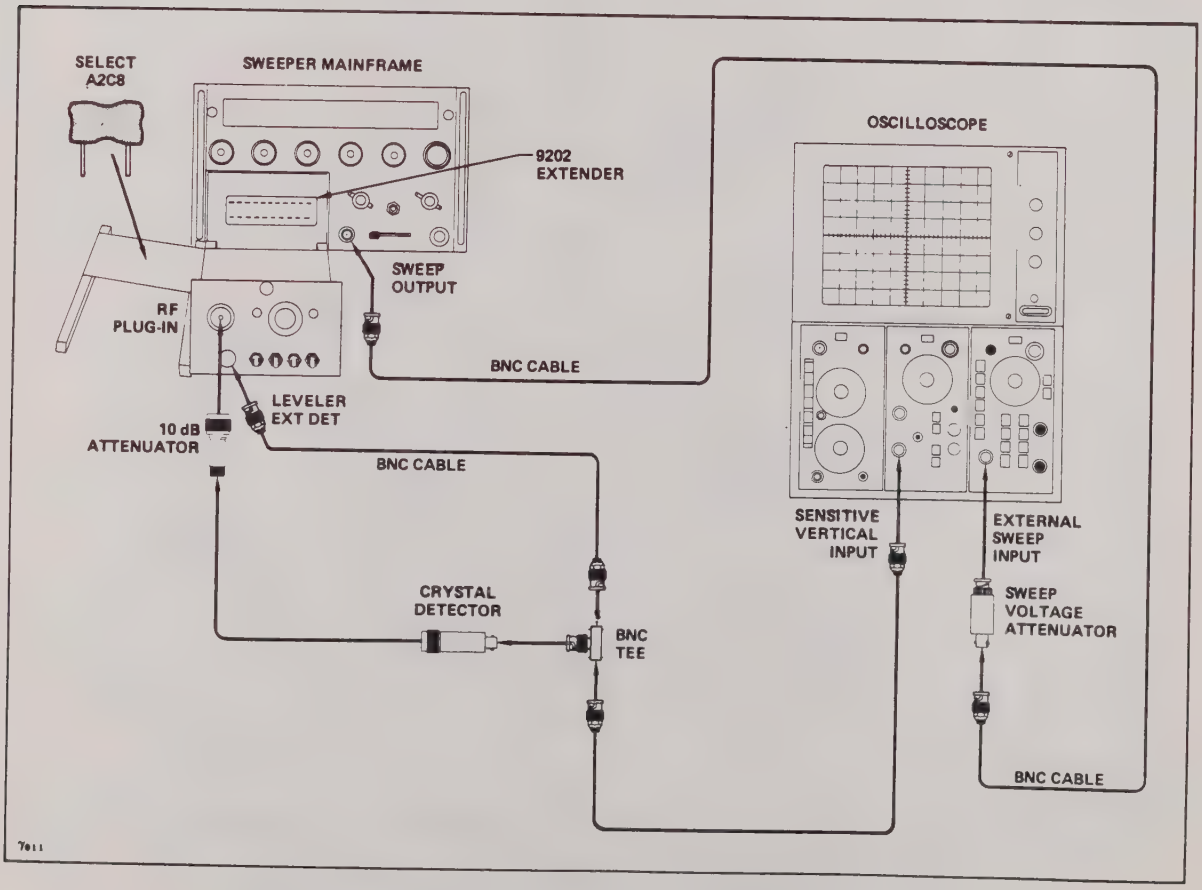


Figure 4-23. Test Setup for Leveling Loop Stability Calibration

10. Set the oscilloscope vertical channel sensitivity to 20 mV/Division (this may be changed later for convenience).

11. Set the oscilloscope horizontal channel controls to accept the 0 to 10 V sweep ramp output of the mainframe for horizontal deflection.

12. Adjust the 5013-2 **RF LEVEL** control to the setting which produces the maximum amount of oscillation on the displayed trace.

13. Select the minimum capacitance value for A2C8 which stops the oscillation; the suggested range is 15 to 68 pF. The selected capacitor should have the following characteristics:

    a. Dipped silver-mica construction

    b. Tolerance of ±5%

    c. Voltage rating of 500 Vdc

    d. Lead spacing 0.234 in. (5.94 mm)

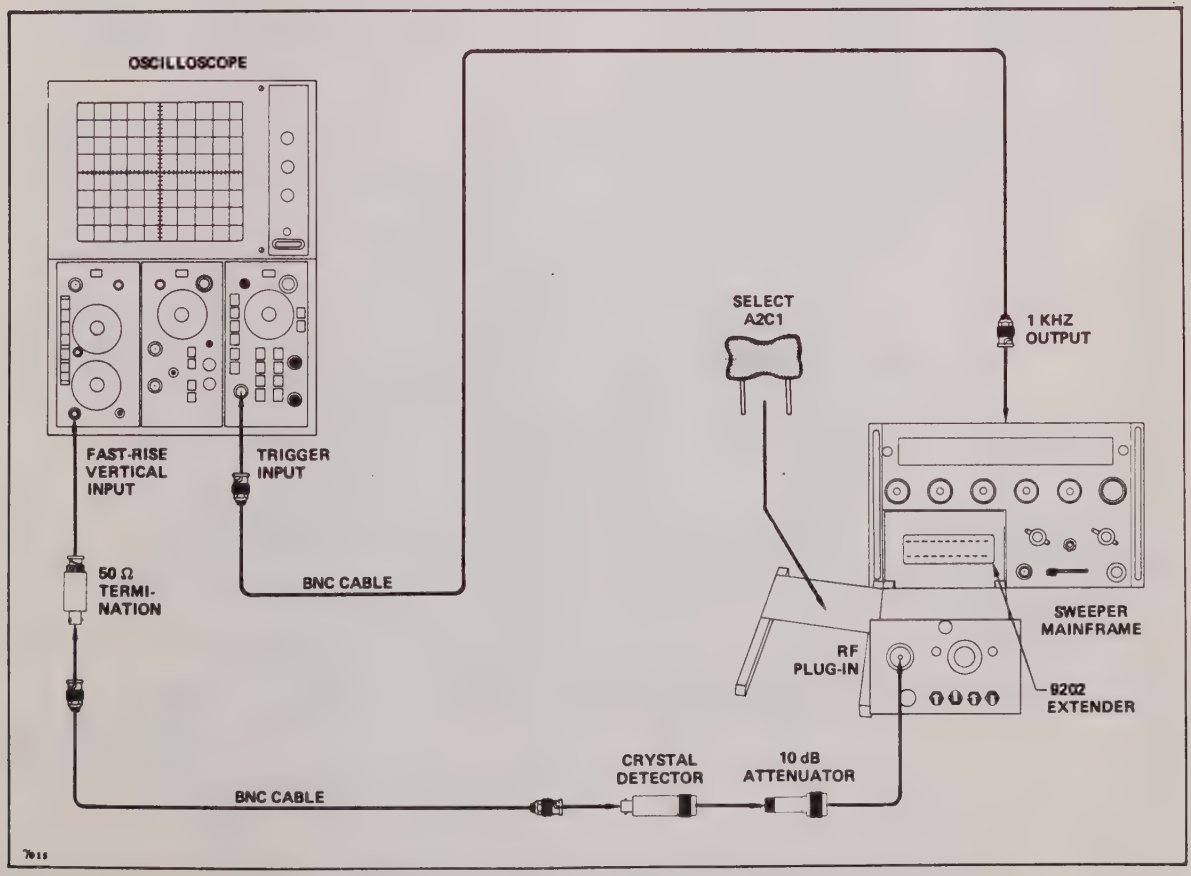


Figure 4-24. Test Setup for Leveling Loop Response Calibration

14. Turn off mainframe power and temporarily solder the selected capacitor for A2C8 in place.

15. Connect the test equipment as shown in Figure 4-24, with the BNC cable connecting the rear-panel **1 KHZ** jack of the mainframe to the "external trigger" input of the oscilloscope delaying time base.

16. Turn on mainframe power.

17. Set the mainframe **MODE** switch to **CW**.

18. Increase the setting of the **RF LEVEL** control to **10**.

19. Adjust the oscilloscope controls as necessary to display the trailing edge of the detected 1 kHz square wave.

20. Select the minimum capacitance value for A2C1 which eliminates ringing and overshoot from the display (refer to Figure 4-25). Too much capacitance will slow the response time of the leveling loop and cause undershoot. The selected capacitor should have the following characteristics:

    a. Dipped silver-mica construction

    b. Tolerance of ±5%

    c. Voltage rating of 500 Vdc

    d. Lead spacing 0.234 in. (5.94 mm)

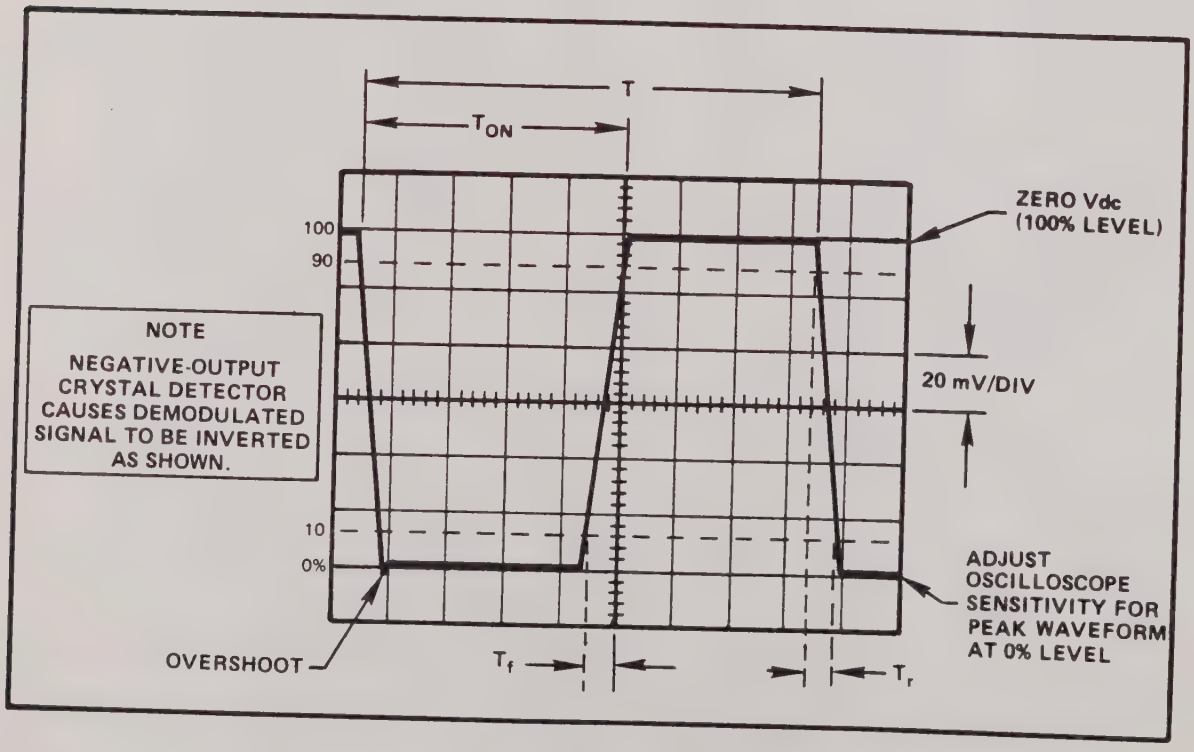


Figure 4-25. Demodulated Square Wave Characteristics

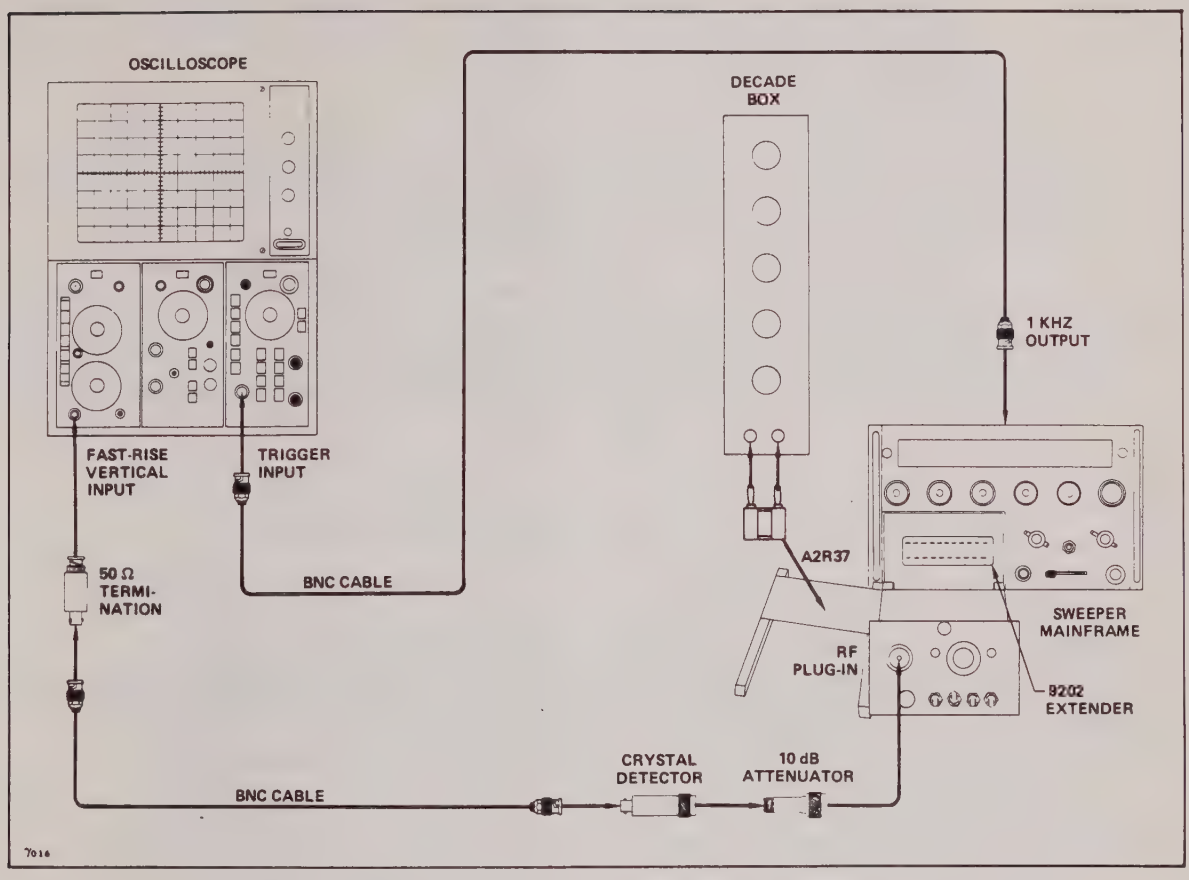


Figure 4-26. Figure 4-26. Test Setup for 1 kHz Symmetry Calibration

21. Turn off mainframe power and temporarily solder the selected capacitor for A2C1 in place.

22. Turn on mainframe power and measure the rise and fall times of the square wave. If either exceeds 10 μs, select a new lower value for A2C8 and/or A2C1.

23. Turn off mainframe power and solder the selected capacitors permanently in place.

4-2.10 1 kHz Square Wave Symmetry

1. Put the 5013-2 in the *service/select-by-test calibration* configuration (refer to Paragraph 4-3.3.2).

2. Remove resistor A2R37 and connect a resistance decade box in its place. Set the resistance value to 9100 Ω.

3. Install the Model 9202 Extender in the mainframe.

4. Mount the 5013-2 to the 9202; support the front of the 5013-2 with non-conductive material.

5. Connect the test equipment as shown in Figure 4-26, with the BNC cable connecting the rear-panel **1 KHZ** jack of the mainframe to the "external trigger" input of the oscilloscope delaying time base.

6. Turn on mainframe power.

7. Set the mainframe **MODE** switch to **CW**.

8. Increase the setting of the **RF LEVEL** control to **10**.

9. Adjust the oscilloscope controls as necessary to display the detected 1 kHz square wave.

10. Select a resistance value for A2R37 which results in minimum symmetry error in the waveform (refer to Figure 4-25). Use the formula:

$$D = \frac{T_{on} - 0.5\,T}{0.5\,T} \times 100$$

Where

D is the symmetry error

T is the period of one complete square wave cycle

T_{on} is the period of the "on" half of the cycle (negative-going when a negative-output crystal detector is used)

11. The maximum allowable value of "D" is 5.

12. Turn off mainframe power.

13. Pick the standard resistor closest to the decade box setting.

14. Permanently solder the selected resistor in place.

SECTION V

MAINTENANCE

5-1. GENERAL

This section contains instructions for routine servicing and cleaning of the 5013-2 and for the isolation and repair of malfunctioning circuits and components.

5-2. ROUTINE MAINTENANCE

In normal laboratory environments, the 5013-2 requires only brief annual service. Ideally, the plug-in and the mainframe in which it is used should be serviced together. If the mainframe has an air filter, inspect it regularly and clean it whenever necessary. The plug-in should also be cleaned at regular intervals:

1. Turn off mainframe power.

2. Loosen the plug-in locking screw and remove the plug-in from the mainframe.

3. Inspect the unit carefully for loose screws, nuts, etc.; tighten any hardware requiring it.

4. Clean all dust and other foreign substances from the plug-in. Use a soft brush and low-pressure dry air. In severe cases, a zero-residue cleaner and degreaser such as trichlorotriflouroethane may be used. This compound is available in an aerosol container as "FD Contact Cleaner" (1638-16S) from Tech-Spray, Amarillo, Texas, or under Federal Stock Number 6850-00105-3084, Cleaning Compound, Solvent. The solvent is also available in liquid form as Genesolv® D from Allied Chemical Corporation.

5. This solvent or isopropyl alcohol may be used to clean residue or metal chips from the inside of the **RF OUT** connector.

6. Clean the dial scale with a clean, soft rag and a mild detergent solution.

CAUTION

DO NOT USE ALCOHOL, BENZENE, OR SOLVENT.

5-3. CALIBRATION

The Performance Checks of Paragraph 4-2 and the Routine Frequency Calibration procedure of Paragraph 4-3.3.1 should be completed annually. The referenced procedures are found in Section IV of this manual.

5-4. CORRECTIVE MAINTENANCE

5-4.1 Trouble Isolation (Figure 5-1)

5-4.1.1 TROUBLE ISOLATION PROCESS. The Performance Checks of Section IV provide the principal means of determining that electrical performance of the 5013-2 is within specified parameters. In the event of evident failure or malfunction, certain logical steps must be followed and decisions made to effect repair or correct a malfunction within the shortest period possible. The basic process may be summarized as follows:

1. Does a malfunction in fact exist, or is an evident malfunction the result of incorrect switch or control positioning, incorrect external input signals, or misapplication of the sweeper/plug-in system?

2. If a malfunction does exist, is the fault in the plug-in or in the mainframe?

3. If the malfunction is within the plug-in, in which circuit or circuits is it located?

4. Which components within the affected circuits have malfunctioned?

5. What caused the malfunction, and will simple replacement of faulty components solve the problem permanently?

5-4.1.2 **SUPPORTING INFORMATION.** Figure 5-1 is an aid to trouble isolation, to be used in conjunction with the following information:

1. The detailed circuit descriptions and block diagrams in Sections VI, VIII, and IX.

2. The schematic diagrams and board component-location drawings in Sections VIII and IX and the chassis wiring diagram in Section VII.

3. The basing diagrams of multi-lead semiconductor devices used in the plug-in, shown on the wiring diagram of the 5013-2 (Figure 7-2), the A1 board assembly (Figure 8-3), the A2 board assembly (Figure 9-3), or the A3 board assembly (Figure 9-4).

4. The subassembly and component location information in Figures 4-14 and 7-1.

5-4.1.3 **TROUBLE ISOLATION DIAGRAMS.** Figure 5-1 is one of three separate sequences and several sub-sequences used to isolate malfunctions from the system level, to the malfunctioning circuit, to the malfunctioning individual component. Figure 5-1, located at the end of this section, is organized as follows:

1. *START Sequence.* This sequence is used to direct the troubleshooter to the malfunctioning circuit area within the sweeper mainframe/plug-in system.

2. *Sequence A* is concerned with active and passive RF components.

3. *Sequence B* is the troubleshooting figure related to the frequency control circuits and tuning coil drivers.

4. *Sequence C* is concerned with the amplitude control and leveling functions.

Trouble isolation information in Figure 5-1 will guide the repair technician to malfunctioning chassis-mounted components and complete assemblies.

Trouble isolation diagrams for printed circuit assembly A1 (oscillator driver) are found in Section VIII of this manual. Trouble isolation diagrams for printed circuit assemblies A2 (leveler/AM) and A3 (power meter leveling) are in Section IX.

5-4.2 Test Equipment

The calibration test equipment listed in Table 4-4, Section IV, should be used for trouble isolation.

CAUTION

BE VERY CAREFUL WITH OSCILLOSCOPE AND VOLTMETER PROBES TO AVOID ACCIDENTALLY BRIDGING TWO POINTS OR SHORT-CIRCUITING A WIRE OR COMPONENT LEAD TO GROUND. LACK OF ADEQUATE CARE WITH SEMICONDUCTOR AND INTEGRATED CIRCUITS CAN TURN RELATIVELY MINOR PROBLEMS INTO COSTLY EXPERIENCES.

Systron-Donner Extender Model 9202 and Plug-in Inverter Model 9203 are required for trouble isolation and repair of the plug-in.

5-4.3 Printed Circuit Board Repair

Repair of the plug-in comprises location and replacement of defective components. To avoid damage to the printed circuit boards and precision components, solder or remove components only with a low-power (25 to 50 W, 500 to 650°) soldering iron. Do not use soldering guns or large irons. Use only 60-40 or 63-37 rosin core solder. To remove the integrated circuit operational amplifiers or other multi-lead devices, use a special iron tip that unsolders all leads at the same time (available from Ungar and other manufacturers). Remove excess solder from circuit board holes with a vacuum de-soldering device (available from Edsyn, Ungar, Wen, Viking, etc.).

5-4.5 Component Removal and Re-assembly

Refer to Paragraph 4-3.3.2, Section IV, for instructions to place the plug-in in its *service and select-by-test calibration* configuration. For disassembly to a greater depth, use the *Illustrated Parts Breakdown* — Figure 7-1 of Section VII — as a guide to disassembly and reassembly sequences.

Use the following method to assure reliable mating and low VSWR when reassembling the SMA connector pairs used inside the 5013-2:

1. Remove metal particles or other foreign material from both connectors using a Q-Tip® moistened with isopropyl alcohol.

IMPORTANT

Do not use aromatic or chlorinated hydrocarbons, esters, ethers, terpenes, higher alcohols, ketones, or ether-alcohols such as benzene, toluene, turpentine, dioxane, gasoline, cellosolve acetone, or carbon tetrachloride. Keep exposure of the connector parts to the alcohol and its vapors as brief as possible.

2. Remove all alcohol from the connectors and allow them to dry thoroughly.

3. Mate the connectors straight on and tighten with hand pressure only. Disconnect and inspect the pair if unusual resistance is felt as the connectors are being mated; the center conductor may be misaligned.

4. Tighten the connector nut to 8 ±1 inch-pounds with a 5/16 inch torque wrench.

5-4.6 Oscillator Module Repair and Replacement

The oscillator module is the single most expensive item in the 5013-2. Before ordering a replacement oscillator module, you may wish to consider the following:

1. Absence of RF output power is not necessarily indicative of a malfunctioning oscillator. A malfunction in the operating voltage regulating circuitry could reduce or increase the operating voltage beyond the narrow range over which the oscillator is designed to operate.

2. An oscillator to which no tuning current is applied may have no RF output; the tuning components within the oscillator will not be magnetically saturated.

3. Printed circuit oscillator driver assembly A1 contains over-voltage, over-current, and reverse polarity protection for the oscillator V_c and V_t drives. In addition, the oscillator modules themselves have over-voltage Zener diodes. In the event of malfunction, one or more of these protective devices may be destroyed. It is imperative that the following components be replaced in this event, even though their absence will not affect normal operation:

   a. Zener diode A1VR9

   b. SCR A1Q8

   c. Diode A2CR8

   d. Zener diode A2VR11

IMPORTANT

Do not attempt to replace over-voltage Zener diode Y1VR1 mounted to the outside of the oscillator module itself. It should be replaced only at the factory level to ensure that subsequent oscillator damage will not occur.

CAUTION

THE OSCILLATOR MODULE MUST NOT BE OPERATED WITH THE OVER-VOLTAGE DIODE REMOVED.

4. A "dead" oscillator module may be repairable at the factory level, and you may wish to consider this option. The oscillator module is not field-repairable.

5. When replacing an oscillator module, the white/green wire must not be connected until the instruction to do so is reached during performance of the *oscillator voltage setting procedure*, Paragraph 4-3.7 of Section IV.

6. A jumper wire from **–HTR** to ground and Zener diode CR14 must be soldered to the oscillator module before it is installed in the 5013-2. Refer to Figure 5-2 of this section.

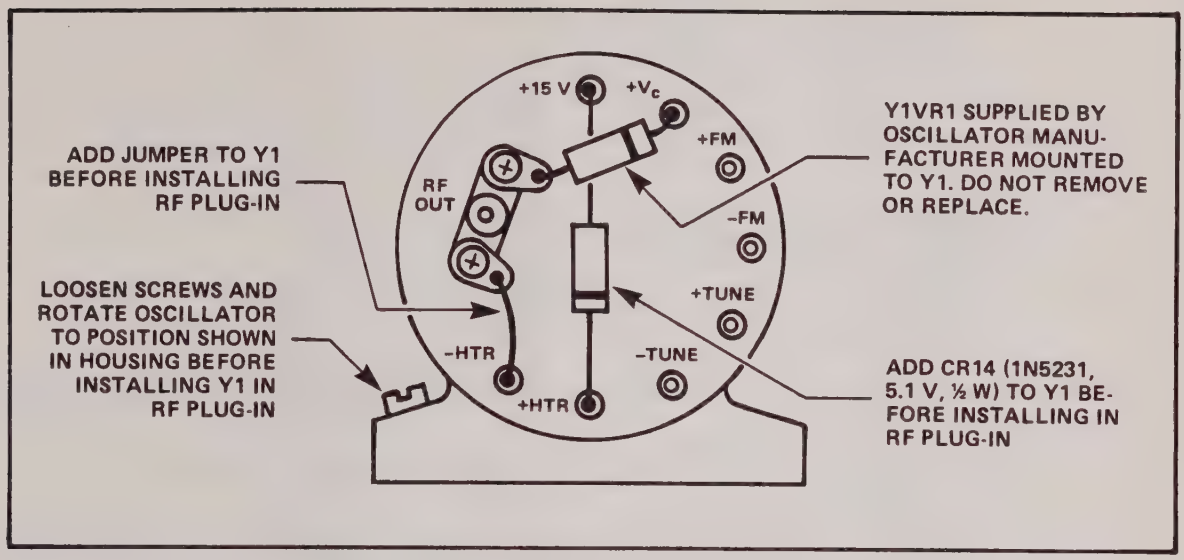

ADD JUMPER TO Y1 BEFORE INSTALLING RF PLUG-IN
LOOSEN SCREWS AND ROTATE OSCILLATOR TO POSITION SHOWN IN HOUSING BEFORE INSTALLING Y1 IN RF PLUG-IN
+15 V
+Vc
+FM
-FM
+TUNE
-TUNE
RF OUT
-HTR
+HTR
Y1VR1 SUPPLIED BY OSCILLATOR MANUFACTURER MOUNTED TO Y1. DO NOT REMOVE OR REPLACE.
ADD CR14 (1N5231, 5.1 V, ½ W) TO Y1 BEFORE INSTALLING IN RF PLUG-IN

Figure 5-2. Oscillator Module Y1 External Components

5-5. MODIFICATIONS AND OPTIONS

5-5.1 Option M3, Fast AM (Front Panel Input)

This option is installable at factory level only.

5-5.2 Option M3A, Fast AM (Rear Panel Input)

This option is installable at factory level only.

5-5.3 Option M6, Wide Deviation Phase Lock

The user may modify the 5013-2 plug-in to this configuration whenever the wide phase lock deviation capability is desired. Refer to Table 1-1 (Section I) for applicable performance specifications, to Figure 4-14 (Section IV) for component location information, and to wiring diagram Figure 7-2 (Section VII):

1. Place the RF plug-in in the *service and select-by-test calibration* configuration described in Paragraph 4-3.3.2, Section IV.
2. Locate the gray twin-conductor shielded cable connected to the **+FM** and **–FM** terminals of the oscillator module.
3. Disconnect the black wire originating at P20-10 from the **–FM** terminal.
4. Disconnect the red wire originating at P20-11 from the **+FM** terminal.
5. Disconnect the clear shield wire from the oscillator ground terminal.
6. Insulate the ends of the wires removed in Steps *3* through *5* and tie them into the wire harness.

7. Disconnect the black wire from P20-10.

8. Disconnect the red wire from P20-11.

9. Insulate the ends of the wires removed in Steps *7* and *8* and tie them into the wire harness.

10. Solder a 2 inch (5 cm) red wire from P20-11 to terminal **L** of printed circuit assembly A1.

11. Solder a 2 inch (5 cm) black wire from P20-10 to terminal **H** of printed circuit assembly A1.

12. Solder a short piece of bus wire between the **+FM** and **–FM** terminals of the oscillator module.

13. Re-assemble the plug-in; install new cable straps if any were removed during the modification.

14. The phase lock input will now be considerably more sensitive to electrical noise and electromagnetic radiation. It is important that the **PHASE LOCK** connector on the rear panel of the mainframe or adapter be kept short-circuited when not in use by removing the mating plug completely or by inserting a shorting plug. Do not leave an unterminated input cable attached to the **PHASE LOCK** connector.

5-5.4 Option M7, Negative Power Meter Leveling

This option is installable at factory level only.

5-5.5 Option M7A, Positive Power Meter Leveling

This option is installable at factory level only.

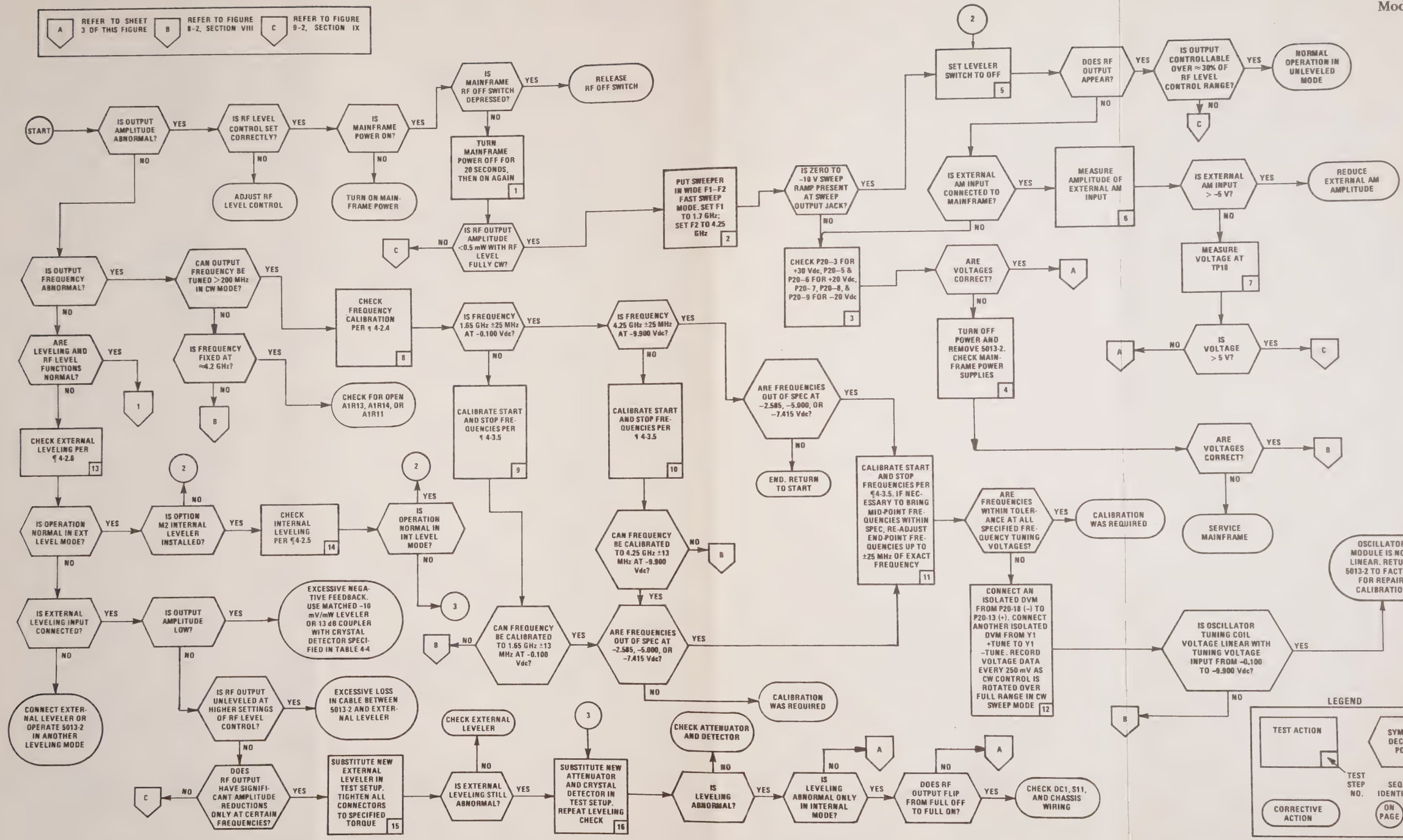

A REFER TO SHEET 3 OF THIS FIGURE
B REFER TO FIGURE 8-2, SECTION VIII
C REFER TO FIGURE 9-2, SECTION IX
START
IS OUTPUT AMPLITUDE ABNORMAL?
IS RF LEVEL CONTROL SET CORRECTLY?
ADJUST RF LEVEL CONTROL
IS MAINFRAME POWER ON?
TURN ON MAIN-FRAME POWER
IS MAINFRAME RF OFF SWITCH DEPRESSED?
RELEASE RF OFF SWITCH
TURN MAINFRAME POWER OFF FOR 20 SECONDS, THEN ON AGAIN 1
IS RF OUTPUT AMPLITUDE <0.5 mW WITH RF LEVEL FULLY CW?
PUT SWEEPER IN WIDE F1–F2 FAST SWEEP MODE. SET F1 TO 1.7 GHz; SET F2 TO 4.25 GHz 2
IS ZERO TO –10 V SWEEP RAMP PRESENT AT SWEEP OUTPUT JACK?
SET LEVELER SWITCH TO OFF 5
DOES RF OUTPUT APPEAR?
IS OUTPUT CONTROLLABLE OVER ≈30% OF RF LEVEL CONTROL RANGE?
NORMAL OPERATION IN UNLEVELED MODE
IS EXTERNAL AM INPUT CONNECTED TO MAINFRAME?
MEASURE AMPLITUDE OF EXTERNAL AM INPUT 6
IS EXTERNAL AM INPUT > –5 V?
REDUCE EXTERNAL AM AMPLITUDE
CHECK P20–3 FOR +30 Vdc, P20–5 & P20–6 FOR +20 Vdc, P20–7, P20–8, & P20–9 FOR –20 Vdc 3
ARE VOLTAGES CORRECT?
MEASURE VOLTAGE AT TP18 7
TURN OFF POWER AND REMOVE 5013-2. CHECK MAIN-FRAME POWER SUPPLIES 4
IS VOLTAGE > 5 V?
IS OUTPUT FREQUENCY ABNORMAL?
CAN OUTPUT FREQUENCY BE TUNED > 200 MHz IN CW MODE?
CHECK FREQUENCY CALIBRATION PER ¶ 4-2.4 8
IS FREQUENCY 1.65 GHz ±25 MHz AT –0.100 Vdc?
IS FREQUENCY 4.25 GHz ±25 MHz AT –9.900 Vdc?
ARE FREQUENCIES OUT OF SPEC AT –2.585, –5.000, OR –7.415 Vdc?
END. RETURN TO START
ARE LEVELING AND RF LEVEL FUNCTIONS NORMAL?
IS FREQUENCY FIXED AT ≈4.2 GHz?
CHECK FOR OPEN A1R13, A1R14, OR A1R11
CALIBRATE START AND STOP FRE-QUENCIES PER ¶ 4-3.5 9
CALIBRATE START AND STOP FRE-QUENCIES PER ¶ 4-3.5 10
CALIBRATE START AND STOP FREQUENCIES PER ¶4-3.5. IF NEC-ESSARY TO BRING MID-POINT FRE-QUENCIES WITHIN SPEC, RE-ADJUST END-POINT FRE-QUENCIES UP TO ±25 MHz OF EXACT FREQUENCY 11
ARE FREQUENCIES WITHIN TOLER-ANCE AT ALL SPECIFIED FRE-QUENCY TUNING VOLTAGES?
CALIBRATION WAS REQUIRED
CHECK EXTERNAL LEVELING PER ¶ 4-2.6 13
IS OPERATION NORMAL IN EXT LEVEL MODE?
IS OPTION M2 INTERNAL LEVELER INSTALLED?
CHECK INTERNAL LEVELING PER ¶ 4-2.5 14
IS OPERATION NORMAL IN INT LEVEL MODE?
CAN FREQUENCY BE CALIBRATED TO 4.25 GHz ±13 MHz AT –9.900 Vdc?
CONNECT AN ISOLATED DVM FROM P20-18 (–) TO P20-13 (+). CONNECT ANOTHER ISOLATED DVM FROM Y1 +TUNE TO Y1 –TUNE. RECORD VOLTAGE DATA EVERY 250 mV AS CW CONTROL IS ROTATED OVER FULL RANGE IN CW SWEEP MODE 12
IS OSCILLATOR TUNING COIL VOLTAGE LINEAR WITH TUNING VOLTAGE INPUT FROM –0.100 TO –9.900 Vdc?
OSCILLATOR MODULE IS NON-LINEAR. RETURN 5013-2 TO FACTORY FOR REPAIR/ CALIBRATION
IS EXTERNAL LEVELING INPUT CONNECTED?
IS OUTPUT AMPLITUDE LOW?
EXCESSIVE NEGA-TIVE FEEDBACK. USE MATCHED –10 mV/mW LEVELER OR 13 dB COUPLER WITH CRYSTAL DETECTOR SPECI-FIED IN TABLE 4-4
CONNECT EXTER-NAL LEVELER OR OPERATE 5013-2 IN ANOTHER LEVELING MODE
IS RF OUTPUT UNLEVELED AT HIGHER SETTINGS OF RF LEVEL CONTROL?
EXCESSIVE LOSS IN CABLE BETWEEN 5013-2 AND EXTER-NAL LEVELER
CAN FREQUENCY BE CALIBRATED TO 1.65 GHz ±13 MHz AT –0.100 Vdc?
ARE FREQUENCIES OUT OF SPEC AT –2.585, –5.000, OR –7.415 Vdc?
CALIBRATION WAS REQUIRED
DOES RF OUTPUT HAVE SIGNIFI-CANT AMPLITUDE REDUCTIONS ONLY AT CERTAIN FREQUENCIES?
SUBSTITUTE NEW EXTERNAL LEVELER IN TEST SETUP. TIGHTEN ALL CONNECTORS TO SPECIFIED TORQUE 15
CHECK EXTERNAL LEVELER
IS EXTERNAL LEVELING STILL ABNORMAL?
SUBSTITUTE NEW ATTENUATOR AND CRYSTAL DETECTOR IN TEST SETUP. REPEAT LEVELING CHECK 16
CHECK ATTENUATOR AND DETECTOR
IS LEVELING ABNORMAL?
IS LEVELING ABNORMAL ONLY IN INTERNAL MODE?
DOES RF OUTPUT FLIP FROM FULL OFF TO FULL ON?
CHECK DC1, S11, AND CHASSIS WIRING
ARE VOLTAGES CORRECT?
SERVICE MAINFRAME
LEGEND
TEST ACTION
TEST STEP NO.
SYMPTOM DECISION POINT
SEQUENCE IDENTIFICATION
CORRECTIVE ACTION
ON PAGE
OFF PAGE

Figure 5-1. Troubleshooting Diagram (Sheet 1)

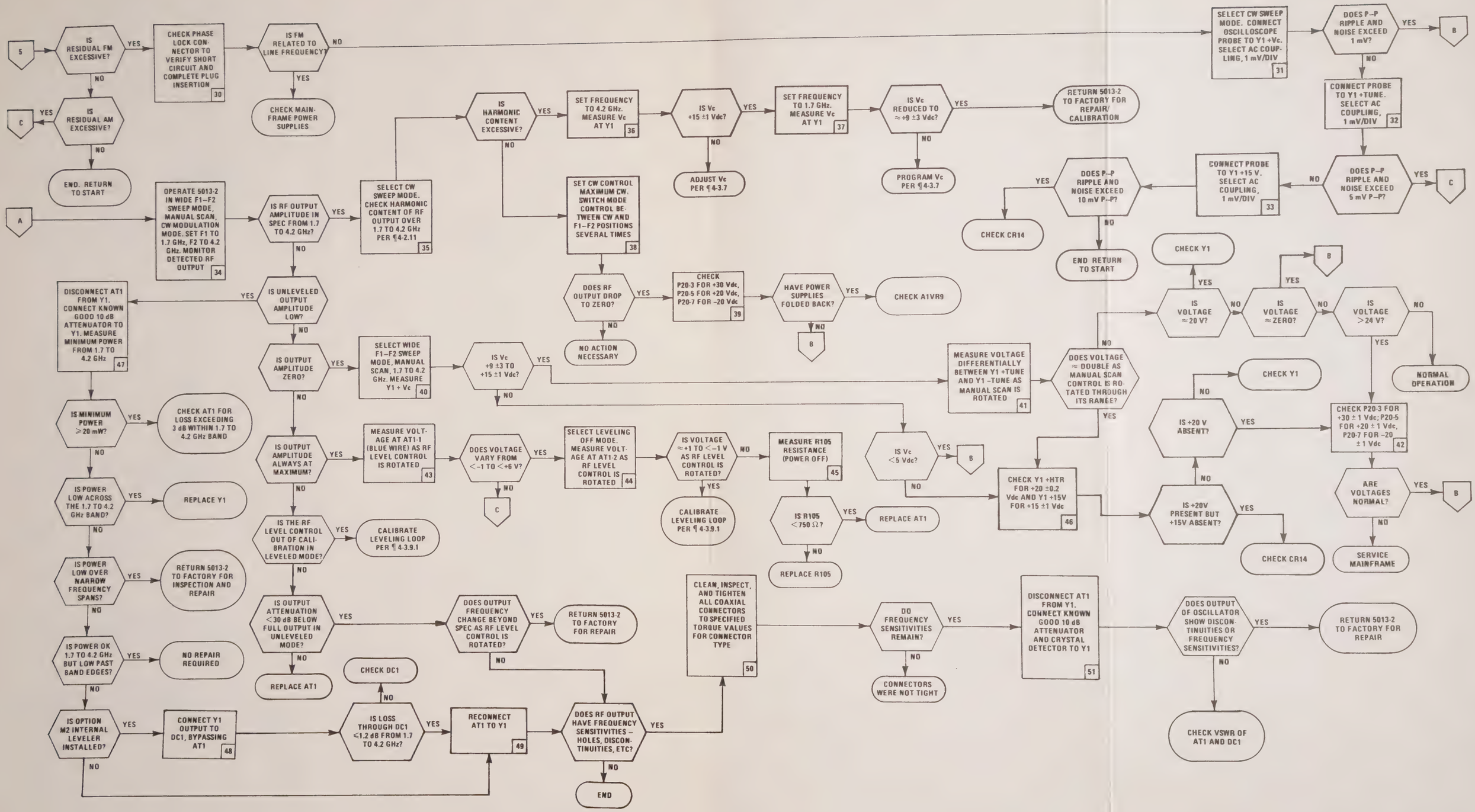

5
IS RESIDUAL FM EXCESSIVE?
YES
NO
CHECK PHASE LOCK CONNECTOR TO VERIFY SHORT CIRCUIT AND COMPLETE PLUG INSERTION 30
IS FM RELATED TO LINE FREQUENCY?
YES
CHECK MAINFRAME POWER SUPPLIES
NO
C
IS RESIDUAL AM EXCESSIVE?
YES
NO
END. RETURN TO START
A
OPERATE 5013-2 IN WIDE F1–F2 SWEEP MODE, MANUAL SCAN, CW MODULATION MODE. SET F1 TO 1.7 GHz, F2 TO 4.2 GHz. MONITOR DETECTED RF OUTPUT 34
IS RF OUTPUT AMPLITUDE IN SPEC FROM 1.7 TO 4.2 GHz?
YES
NO
SELECT CW SWEEP MODE. CHECK HARMONIC CONTENT OF RF OUTPUT OVER 1.7 TO 4.2 GHz PER ¶4-2.11 35
IS HARMONIC CONTENT EXCESSIVE?
YES
NO
SET FREQUENCY TO 4.2 GHz. MEASURE Vc AT Y1 36
IS Vc +15 ±1 Vdc?
YES
NO
ADJUST Vc PER ¶4-3.7
SET FREQUENCY TO 1.7 GHz. MEASURE Vc AT Y1 37
IS Vc REDUCED TO ≈+9 ±3 Vdc?
YES
NO
PROGRAM Vc PER ¶4-3.7
RETURN 5013-2 TO FACTORY FOR REPAIR/ CALIBRATION
SET CW CONTROL MAXIMUM CW. SWITCH MODE CONTROL BETWEEN CW AND F1–F2 POSITIONS SEVERAL TIMES 38
DOES RF OUTPUT DROP TO ZERO?
YES
NO
NO ACTION NECESSARY
CHECK P20-3 FOR +30 Vdc, P20-5 FOR +20 Vdc, P20-7 FOR –20 Vdc 39
HAVE POWER SUPPLIES FOLDED BACK?
YES
NO
B
CHECK A1VR9
SELECT CW SWEEP MODE. CONNECT OSCILLOSCOPE PROBE TO Y1 +Vc. SELECT AC COUPLING, 1 mV/DIV 31
DOES P–P RIPPLE AND NOISE EXCEED 1 mV?
YES
NO
B
CONNECT PROBE TO Y1 +TUNE. SELECT AC COUPLING, 1 mV/DIV 32
DOES P–P RIPPLE AND NOISE EXCEED 5 mV P–P?
YES
NO
C
CONNECT PROBE TO Y1 +15 V. SELECT AC COUPLING, 1 mV/DIV 33
DOES P–P RIPPLE AND NOISE EXCEED 10 mV P–P?
YES
NO
CHECK CR14
END. RETURN TO START
DISCONNECT AT1 FROM Y1. CONNECT KNOWN GOOD 10 dB ATTENUATOR TO Y1. MEASURE MINIMUM POWER FROM 1.7 TO 4.2 GHz 47
IS UNLEVELED OUTPUT AMPLITUDE LOW?
YES
NO
IS OUTPUT AMPLITUDE ZERO?
YES
NO
SELECT WIDE F1–F2 SWEEP MODE, MANUAL SCAN, 1.7 TO 4.2 GHz. MEASURE Y1 + Vc 40
IS Vc +9 ±3 TO +15 ±1 Vdc?
YES
NO
MEASURE VOLTAGE DIFFERENTIALLY BETWEEN Y1 +TUNE AND Y1 –TUNE AS MANUAL SCAN IS ROTATED 41
DOES VOLTAGE ≈ DOUBLE AS MANUAL SCAN CONTROL IS ROTATED THROUGH ITS RANGE?
NO
YES
IS VOLTAGE ≈ 20 V?
YES
NO
CHECK Y1
IS VOLTAGE ≈ ZERO?
YES
NO
B
IS VOLTAGE >24 V?
YES
NO
NORMAL OPERATION
CHECK Y1
NO
IS +20 V ABSENT?
YES
NO
CHECK P20-3 FOR +30 ± 1 Vdc; P20-5 FOR +20 ± 1 Vdc, P20-7 FOR –20 ± 1 Vdc 42
ARE VOLTAGES NORMAL?
YES
NO
B
SERVICE MAINFRAME
IS +20V PRESENT BUT +15V ABSENT?
YES
NO
CHECK CR14
IS Vc <5 Vdc?
YES
NO
B
CHECK Y1 +HTR FOR +20 ±0.2 Vdc AND Y1 +15V FOR +15 ±1 Vdc 46
IS OUTPUT AMPLITUDE ALWAYS AT MAXIMUM?
YES
NO
MEASURE VOLTAGE AT AT1-1 (BLUE WIRE) AS RF LEVEL CONTROL IS ROTATED 43
DOES VOLTAGE VARY FROM <–1 TO <+6 V?
YES
NO
C
SELECT LEVELING OFF MODE. MEASURE VOLTAGE AT AT1-2 AS RF LEVEL CONTROL IS ROTATED 44
IS VOLTAGE ≈+1 TO <–1 V AS RF LEVEL CONTROL IS ROTATED?
YES
NO
CALIBRATE LEVELING LOOP PER ¶ 4-3.9.1
MEASURE R105 RESISTANCE (POWER OFF) 45
IS R105 <750 Ω?
YES
NO
REPLACE AT1
REPLACE R105
IS THE RF LEVEL CONTROL OUT OF CALIBRATION IN LEVELED MODE?
YES
NO
CALIBRATE LEVELING LOOP PER ¶ 4-3.9.1
IS OUTPUT ATTENUATION <30 dB BELOW FULL OUTPUT IN UNLEVELED MODE?
YES
NO
REPLACE AT1
DOES OUTPUT FREQUENCY CHANGE BEYOND SPEC AS RF LEVEL CONTROL IS ROTATED?
YES
NO
RETURN 5013-2 TO FACTORY FOR REPAIR
CLEAN, INSPECT, AND TIGHTEN ALL COAXIAL CONNECTORS TO SPECIFIED TORQUE VALUES FOR CONNECTOR TYPE 50
DO FREQUENCY SENSITIVITIES REMAIN?
YES
NO
CONNECTORS WERE NOT TIGHT
DISCONNECT AT1 FROM Y1. CONNECT KNOWN GOOD 10 dB ATTENUATOR AND CRYSTAL DETECTOR TO Y1 51
DOES OUTPUT OF OSCILLATOR SHOW DISCONTINUITIES OR FREQUENCY SENSITIVITIES?
YES
NO
RETURN 5013-2 TO FACTORY FOR REPAIR
CHECK VSWR OF AT1 AND DC1
IS MINIMUM POWER ≥20 mW?
YES
NO
CHECK AT1 FOR LOSS EXCEEDING 3 dB WITHIN 1.7 TO 4.2 GHz BAND
IS POWER LOW ACROSS THE 1.7 TO 4.2 GHz BAND?
YES
NO
REPLACE Y1
IS POWER LOW OVER NARROW FREQUENCY SPANS?
YES
NO
RETURN 5013-2 TO FACTORY FOR INSPECTION AND REPAIR
IS POWER OK 1.7 TO 4.2 GHz BUT LOW PAST BAND EDGES?
YES
NO
NO REPAIR REQUIRED
IS OPTION M2 INTERNAL LEVELER INSTALLED?
YES
NO
CONNECT Y1 OUTPUT TO DC1, BYPASSING AT1 48
CHECK DC1
NO
IS LOSS THROUGH DC1 ≤1.2 dB FROM 1.7 TO 4.2 GHz?
YES
RECONNECT AT1 TO Y1 49
DOES RF OUTPUT HAVE FREQUENCY SENSITIVITIES – HOLES, DISCONTINUITIES, ETC?
YES
NO
END

Figure 5-1. Troubleshooting Diagram (Sheet 2)

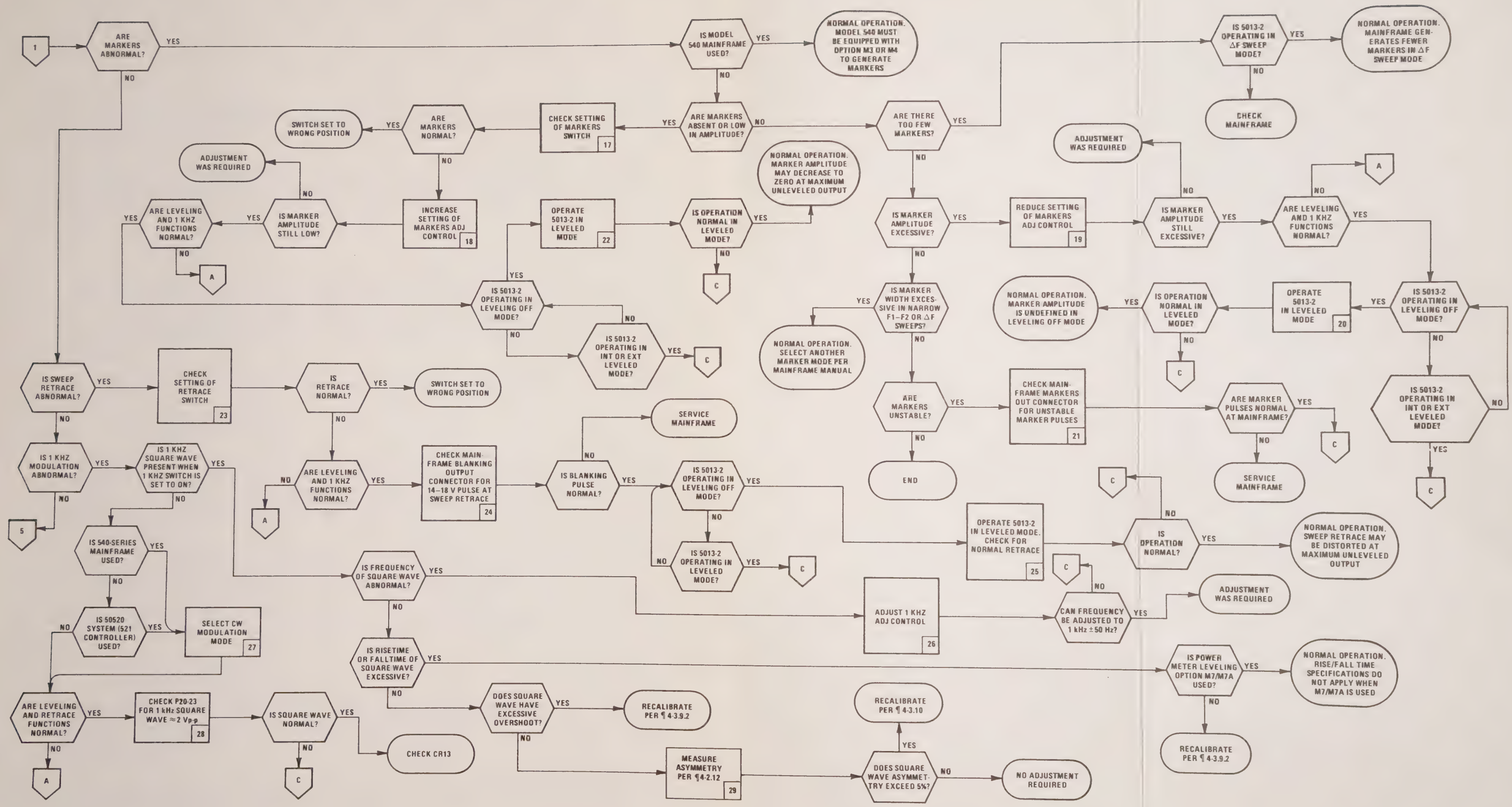


Figure 5-1. Troubleshooting Diagram (Sheet 3)

SECTION VI

THEORY OF OPERATION

6-1. OVERALL FUNCTIONAL DESCRIPTION (Figure 6-1)

Figure 6-1 is a simplified block diagram of the Model 5013-2 RF Plug-in. The user is also referred to the mainframe instruction manual, which describes the interconnections and interrelationships between the mainframe and RF plug-in.

The RF plug-in accepts operating power, frequency-control signals, and amplitude-control signals from the mainframe and generates a predictable band of microwave energy to be used for transmission and/or reflection tests of instruments, systems, or components designed for operation in the 1,700 to 4,200 megahertz range.

6-1.1 Oscillator Driver

Oscillator driver printed circuit assembly A1 accepts the frequency tuning output of the mainframe and sums this voltage with externally-supplied frequency modulation (FM) voltage (Option M6 only). The outputs of A1 drive the heatsink-mounted pass transistors to provide the oscillator module with a regulated current-mode frequency tuning signal (V_t) and programmed voltage-mode operating power (V_c). Regulating circuitry mounted to the oscillator module supplies fixed operating power of plus fifteen volts.

Detailed circuit theory for Oscillator Driver A1 and associated circuits is contained in Section VIII of this manual.

6-1.2 Amplitude Modulation Functions

Amplitude modulation signals from the mainframe (retrace blanking and markers, plus 1 kilohertz and rf-off in some mainframes) and external amplitude modulation signals coupled through the mainframe are summed with leveling feedback signals from an external detector to control the RF output amplitude of the plug-in. Other drive signals generated within the plug-in (power, leveling mode, and 1 kilohertz modulation) also provide drive for the internal RF modulator.

Model 5013-2 RF Plug-ins equipped with Option M3 or M3A accept high-speed amplitude control signals directly into the internal RF modulator. Model 5013-2's equipped with Option M7 or M7A accept the output of a microwave power meter as a leveling input.

Detailed circuit theory for Leveler/Amplitude Modulator A2 and associated circuits is contained in Section IX of this manual.

6-2. OSCILLATOR (Figure 6-2)

The oscillator module used in the 5013-2 is a YIG-tuned source of solid-state design and thin-film gold construction. The oscillator is tuned to the desired frequency by passing a current through an electromagnet coil surrounding a sphere of YIG (yttrium-iron-garnet) material which has been doped with impurities.

The magnetic flux generated by the tuning coil aligns the poles of the YIG sphere; once the material has been magnetically saturated, it can be tuned to resonate at different frequencies at a rate of some 2.8

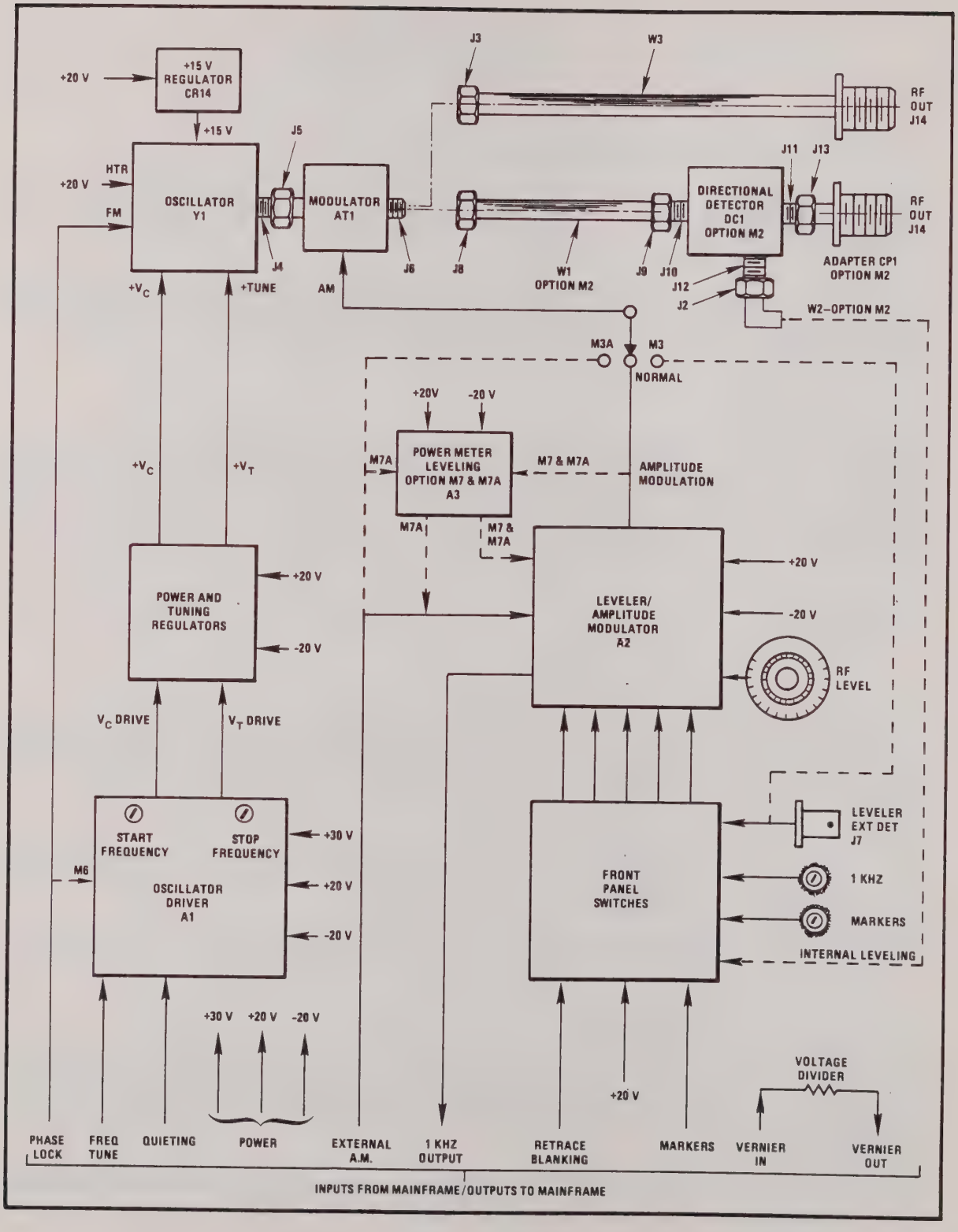


Figure 6-1. Model 5013-2 Block Diagram

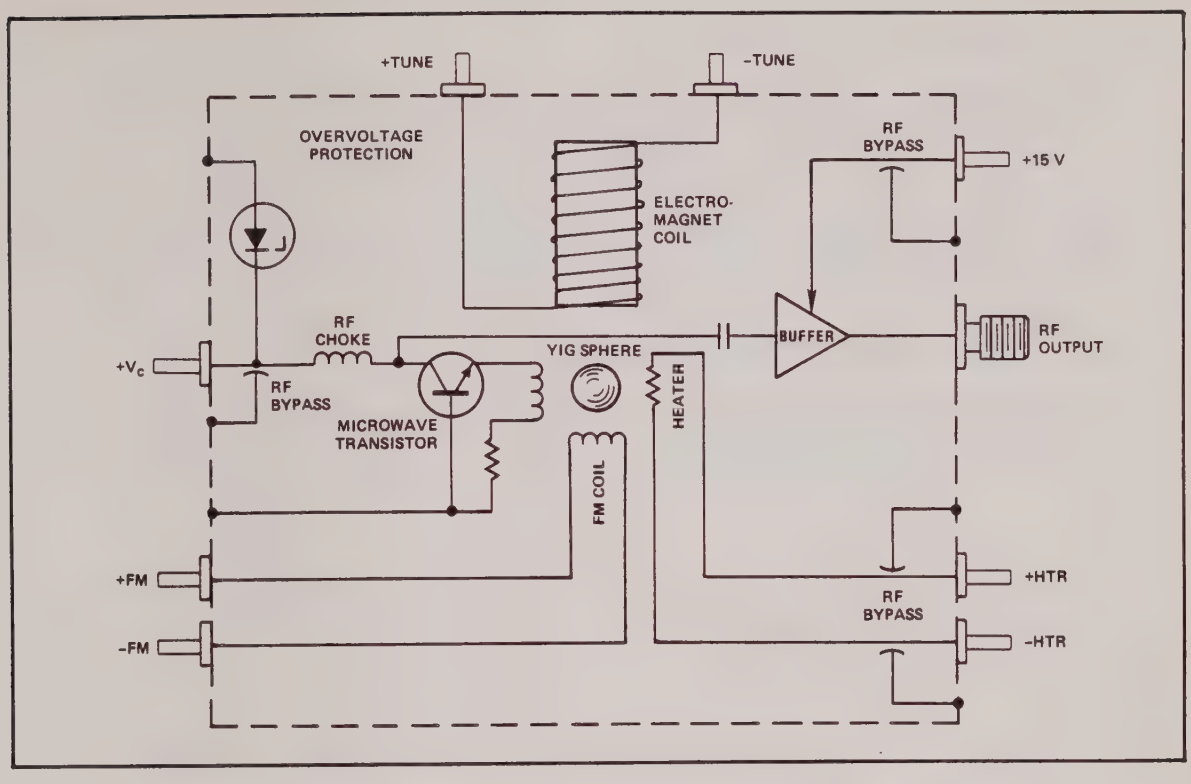


Figure 6-2. Simplified Construction of YIG-tuned Gunn Diode Oscillator

megahertz per Gauss (one Maxwell per square centimeter). This *uniform precessional mode*, as it is known, is defined as the condition in which the magnetic moments of all the atoms in the YIG crystal are parallel and precess in phase about the uniform magnetic field.

The main tuning coil sets the frequency output over the entire operating band of the oscillator. Once the YIG material has been saturated, it tunes linearly with applied electromagnet current. This results in a device which can be tuned predictably and linearly as a function of external drive current.

The oscillator module incorporates two tuning coils; the smaller tuning coil, which is mounted in intimate contact with the YIG sphere, is used for fast frequency modulation over relatively narrow bandwidths. This FM coil is not heavily coupled to the ferromagnetic material around which the main tuning coil is wound; its response is therefore much faster than that of the main tuning coil and hysteresis is so low as to be of no concern.

Oscillator module Y1 is a wideband unit covering the range of 1.65 to 4.25 gigahertz. The active oscillator element is a microwave transistor. The magnetically-saturated YIG sphere acts as a classic resonant circuit for the transistor, tuned by the magnetic flux surrounding the sphere. The output of the transistor is fed to an untuned wideband buffer amplifier which increases the output amplitude and electrically isolates the oscillator transistor from any mismatches or discontinuities at the *rf output* connector of Y1.

6-3. MODULATOR (Figure 6-3)

Modulator assembly AT1 is mounted directly to the *rf output* connector of oscillator Y1. The modulator controls the output amplitude of the 5013-2 by acting as a voltage-controlled attenuator for Y1. The device uses PIN diodes in a shunt configuration. PIN diodes are manufactured so that a thin *intrinsic* region separates the P material from the N material. The storage time of a PIN diode is relatively long, so it does not rectify at microwave frequencies. Instead, it behaves as a variable resistance controlled by the dc current through it. The amount of absorbtion, over a range of at least 30 decibels, is controlled by the leveler/amplitude modulation circuits of the 5013-2.

6-4. DIRECTIONAL DETECTOR (Figure 6-4)

Directional detector DC1, supplied in all 5013-2M2 RF Plug-ins, is an "octave plus" directional coupler with integral matched square-law detector and termination. The unit has a directivity of at least 20 decibels, and is flat within plus or minus 0.7 decibel.

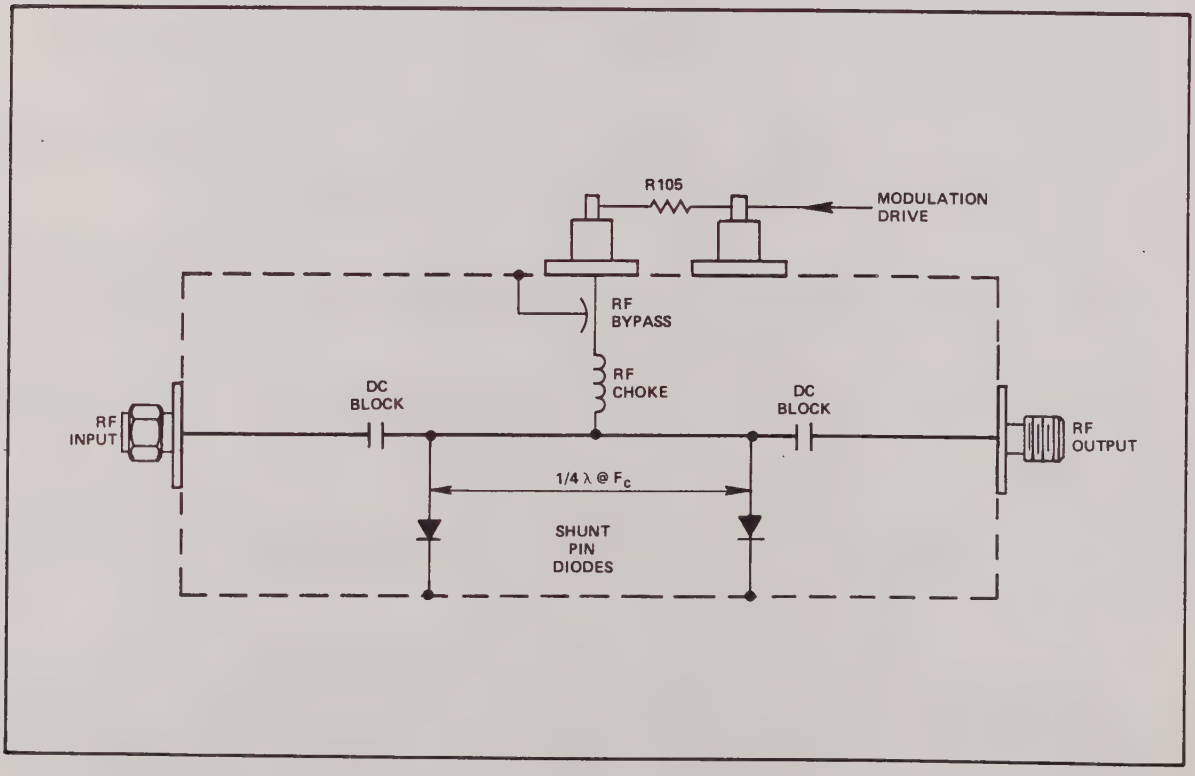


Figure 6-3. Simplified Construction of PIN Diode Modulator

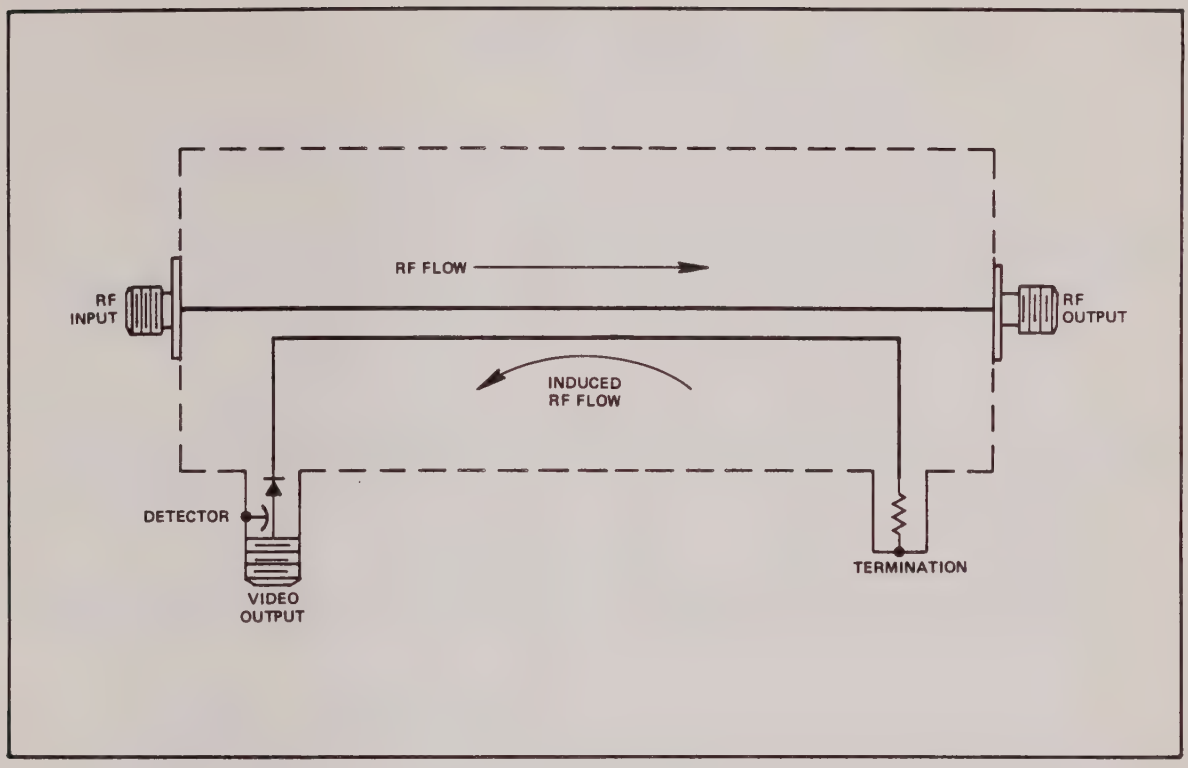


Figure 6-4. Simplified Construction of Directional Detector

SECTION VII

CHASSIS ASSEMBLY

7-1. REPLACEABLE PARTS LIST

Table 7-3 in this section contains a list of replaceable parts and subassemblies for Model 5013-2 RF Plug-in Unit including listings for Options M2, M3, M3A, M7, and M7A. Replaceable parts lists for oscillator driver subassembly A1 are found in Section VIII. Replaceable parts lists for leveler/amplitude modulator subassembly A2 and for power meter leveling subassembly A3 are found in Section IX.

7-1.1 Ordering Replacement Parts

The majority of the electronic parts used in the 5013-2 are standard distributor items, and should be available locally. To order special replacement parts and parts which are not otherwise obtainable, write to Systron-Donner Corporation at the address shown at the front of this manual, or contact your local Scientific Devices office.

Be sure to include the model number (5013-2, 5013-2M7, etc.) and serial number of the unit for which parts are required. Please order by Systron-Donner part number; also include the reference designator where applicable.

7-1.2 Explanation of Table 7-3 Columns

7-1.2.1 FIG. NO./ITEM NO. This column references the figure numbers in which the part can be located and the parts location reference number in the parts breakdown drawing.

7-1.2.2 REF. DESIG. Electronic parts are listed in sequence by reference designation and may be located on the schematic diagram by this designator. Reference designators for components not available separately, which may be ordered only as part of another subassembly, are listed in *italic type.*

7-1.2.3 USE CODE. An entry in this column indicates that the part may not be found in all 5013-2's because it is part of an option, a part replaced when an option is ordered, or an alternate part. Table 7-1 lists the use codes for Model 5013-2.

7-1.2.4 SYSTRON-DONNER PART NUMBER. All standard parts manufactured by Systron-Donner or manufactured to Systron-Donner specifications are listed in this column, but not in the *MFR'S PART NUMBER* column. All other purchased parts which have been assigned Systron-Donner part numbers are also listed in this column. These part numbers must be used when ordering parts.

7-1.2.5 MFR'S PART NUMBER. Commercially-available parts not manufactured by Systron-Donner or to Systron-Donner specifications are listed in this column. Insofar as possible, these part numbers are complete. For best results, always include a complete part description as well as the listed manufacturer's part number when ordering replacement parts from manufacturers or distributors.

7-1.2.6 MFR. CODE. The five-digit Federal Manufacturers' Codes, as listed in Cataloging Handbooks H4-1 and H4-2, are listed in this column. These codes and corresponding manufacturers are listed in Table 7-2.

7-1.2.7 DESCRIPTION. Descriptions of component parts of subassemblies are indented to indicate the parts comprising each subassembly.

Table 7-1. Model 5013-2 Chassis Assembly Use Codes

CODE	EXPLANATION
B	Component which is part of a subassembly within the 5013-2. The size or electrical value of the component is determined by its use in the 5013-2, and is listed in the chassis parts list. No size or value is shown in the parts list for the subassembly, only the use code "B".
F	Component supplied to Systron-Donner Microwave Division specifications. *Manufacturer's standard part may not meet 5013-2 performance specifications unless screened by Microwave Division incoming inspection.*
G	Component supplied by manufacturer as part of purchased subassembly.
H	Modified part; physical alteration required from standard part as supplied by manufacturer before use in 5013-2.
K	Component electrically part of chassis assembly but mounted physically to a subassembly or component part within the 5013-2.
M	Part supplied as part of Option M2, M3, M3A, M7, or M7A.
S	Standard version; part supplied in normally-supplied 5013-2 which may be replaceable by an "M" part if an option is ordered.
T	Component size or electrical value is chosen by test as part of a calibration procedure.

7-1.2.8 QTY. The quantity of the listed part used in a particular application is listed in this column. For example, if four screws are used to mount a subassembly, the number "4" is entered in this column, even if all four of the screws are not shown on the drawing. If two screws identical to these are used elsewhere in the chassis to mount another subassembly, the part will be listed again with the number "2" entered in the *QTY* column. If the same type of screw is to be used to mount an optional component, the screw will be listed a third time with "1" entered in the *QTY* column and the appropriate use coding letter in the *USE CODE* column.

7-1.3 Parts Breakdown

Figure 7-1 is the illustrated parts breakdown for all current versions of the 5013-2; the item numbers shown are used to locate the parts description in Table 7-3. The figure may also be used as a disassembly and reassembly guide.

7-2. SCHEMATIC DIAGRAMS

Figure 7-2 is the schematic/wiring diagram for Model 5013-2. Schematic diagrams for the individual subassemblies A1, A2, and A3 are found in Sections VIII and IX.

Table 7-2. Manufacturers' Codes

CODE	MANUFACTURER
01121	Allen Bradley Co., Milwaukee WI 53204
01220	Systron-Donner Corporation, Microwave Division, Van Nuys CA 91411
02660	Bunker Ramo Corporation, Amphenol Connector Div., Broadview IL 60153
03508	General Electric Co., Semiconductor Products Dept., Auburn NY 13021
04713	Motorola, Inc., Semiconductor Products Group, Phoenix AZ 85008
06090	Raychem Corporation, Menlo Park, CA 94025
06383	Panduit Corporation, Tinley Park IL 60477
09353	C and K Components, Inc., Watertown MA 02172
15907	Micro-Mode Products, Inc., Santee CA 92071
16428	Belden Corporation, Electronic Div., Richmond IN 47374
24539	Avantek, Inc., Santa Clara CA 95051
24546	Corning Glass Works, Electronic Components Div., Bradford PA 16701
26805	Omni Spectra, Inc., Microwave Connector Div., Waltham MA 02154
72982	Erie Technological Products, Inc., Erie PA 16512
75042	TRW Electronic Components, IRC Fixed Resistors, Philadelphia Div., Philadelphia PA 19108
78189	Illinois Tool Works, Shakeproof Div., Elgin IL 60120
79136	Waldes Kohinoor, Inc., Long Island City NY 11101
80294	Bourns, Inc., Instrument Div., Riverside CA 92506
83330	Herman H. Smith Co., Inc., Brooklyn NY 11207
84841	Milford Rivet and Machine Co., New England Div., Milford CT 06460
91637	Dale Electronics, Inc., Columbus NE 68601
93306	Uniform Tubes, Micro Delay Div., Collegeville PA 19426
94222	Southco, Inc., Lester PA 19113
95146	Alco Electronic Products, Inc., Lawrence MA 01842
96906	Military Standards promulgated under authority of Defense Standardization Manual 4120 3-M

Table 7-3. Model 5013-2 RF Plug-in Chassis Parts List

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION	QTY.
7-1							
1	A1		950401		01220	BOARD ASSY – OSCILLATOR DRIVER (Uncalibrated)	1
						Includes:	
	A1C4	B	104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V	1
	A1CR12	B				Not Used	0
	A1R11	B	105490	3305P-1-102	80294	RESISTOR, Variable, 1000 Ω ±5%, (Stop Frequency Adjust)	1
	A1R14	B	104870	RL07S243G	24546	RESISTOR, Metal Film, 24 kΩ ±2%, 1/4 W	1
	A1R16	B	104969	RC07GF564K	01121	RESISTOR, Carbon, 560 kΩ ±10%, 1/4 W	1
	A1R17	B	104870	RL07S243G	24546	RESISTOR, Metal Film, 24 kΩ ±2%, 1/4 W	1
	A1R20	B	104969	RC07GF564K	01121	RESISTOR, Carbon, 560 kΩ ±10%, 1/4 W	1
	A1R24	B				JUMPER WIRE	1
	A1R27	B	104965	RC07GF334K	01121	RESISTOR, Carbon, 330 kΩ ±10%, 1/4 W	1
	A1R28	B				Not Used	0
	A1R29	B				Not Used	0
	A1R38	B	104837	RL07S102G	24546	RESISTOR, Metal Film, 1000 Ω ±2%, 1/4 W	1
	A1R45	T				RESISTOR, Value Selected at Test	1
	A1R46	B				Not Used	0
	A1VR9	B	105551	1N5246A	04713	DIODE, Zener, 16 V ±10%, 1/2 W	1
2	A2		950384		01220	BOARD ASSY – LEVELER/A.M. (Uncalibrated)	1
3	A3	M7	95060501		01220	BOARD ASSY – NEGATIVE POWER METER LEVELING	1
3	A3	M7A	95060502		01220	BOARD ASSY – POSITIVE POWER METER LEVELING	1
4	AT1	F	962324		01220	MODULATOR	1
						Includes:	
—	J5	G				CONNECTOR, SMA Male	1
—	J6	G				CONNECTOR, SMA Female	1
5	CP1	M2	113157	1000-201	15907	ADAPTER, Coaxial, SMA male to N female	1
						Includes:	
—	J13	G				CONNECTOR, SMA Male	1
—	J14	G				CONNECTOR, N Female	1
6	CR13	K	105532	1N4446	03494	DIODE, Silicon, 75 PIV	1
7	CR14	K	105574	1N5231	04713	DIODE, Zener, 5.1 V ±10%, 1/2 W	1
8	DC1	M2,F	962322		01220	DETECTOR, Directional	1
						Includes:	
—	J10	G				CONNECTOR, SMA Female	1
—	J11	G				CONNECTOR, SMA Female	1
—	J12	G				CONNECTOR, SMA Female	1
—	DC1R1	G				TERMINATION, 50Ω SMA	1
—	*J2*	*M2*				*Part of W2*	
—	*J3*	*S*				*Part of W3*	
—	*J4*					*Part of Y1*	
—	*J5*					*Part of AT1*	
—	*J6*					*Part of AT1*	
9	J7		101155	UG-1094/U	02660	CONNECTOR, Receptacle, BNC female (LEVELER EXT DET)	1
—	*J8*	*M2*				*Part of W1*	
—	*J9*	*M2*				*Part of W1*	
—	*J10*	*M2*				*Part of DC1*	
—	*J11*	*M2*				*Part of DC1*	
—	*J12*	*M2*				*Part of DC1*	
—	*J13*	*M2*				*Part of CP1*	
—	*J14*	*M2*				*Part of CP1 (RF OUT 50Ω)*	
—	*J14*	*S*				*Part of W3 (RF OUT 50Ω)*	
10	P20		107094	26-159-24P	02660	CONNECTOR, Plug, 24-pin male	1
11	Q102		101394	2N5190	04713	TRANSISTOR, NPN Silicon, 40 W	1
12	Q103		101394	2N5190	04713	TRANSISTOR, NPN Silicon, 40 W	1
13	R1		104887	RL07S124G	24546	RESISTOR, Metal Film, 120 kΩ ±2%, 1/4 W	1
14	R2		104888	RL07S134G	24546	RESISTOR, Metal Film, 130 kΩ ±2%, 1/4 W	1
15	R3		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W	1
16	R4		105500	WA1G012S103UA	01121	RESISTOR, Variable, 10 kΩ ±10% (MARKER ADJ)	1

Table 7-3. Model 5013-2 RF Plug-in Chassis Parts List (Continued)

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION	QTY.
17	R5		105499	WA1G040P103UA	01121	RESISTOR, Variable, 10 kΩ ±10% (RF LEVEL)	1
18	R6		105500	WAG012S103UA	01121	RESISTOR, Variable, 10 kΩ ±10% (1 KHZ ADJ)	1
19	R8		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W	1
20	R17	T				RESISTOR, Value Selected at Test	1
21	R18	T				RESISTOR, Value Selected at Test	1
22	R104		105458	RH-5-10	91637	RESISTOR, Wirewound, 10 Ω ±1%, 5 W	1
23	R105	T,K				RESISTOR, Value Selected at Test	1
24	S9		105698	MTA-106D	95146	SWITCH, Toggle, SPDT (MARKERS)	1
25	S10		105698	MTA-106D	95146	SWITCH, Toggle, SPDT (RETRACE)	1
26	S11	S	105711	7301	09353	SWITCH, Toggle, 3PDT (LEVELER)	1
26	S11	M2	105715	7303E	09353	SWITCH, Toggle, 3PDT center-off (LEVELER)	1
27	S12		105698	MTA-106D	95146	SWITCH, Toggle, SPDT (1 KHZ)	1
28	S13	M3/M3A	105698	MTA-106D	95146	SWITCH, Toggle, SPDT (FAST AM)	1
28	S19	M7/M7A	105698	MTA-106D	95146	SWITCH, Toggle, SPDT (POWER METER)	1
29	W1	M2	948677		01220	CABLE ASSY – RF (AT1 to DC1)	1
						Containing:	
—	J8	M2	104310	OSM201-2A	16179	CONNECTOR, Cable-Mount, SMA male	1
—	J9	M2	104310	OSM201-2A	16179	CONNECTOR, Cable-Mount, SMA male	1
—		M2	107392	UT85TP	93306	CABLE, Coaxial, 50Ω semi-rigid (0.085 dia.)	A/R
30	W2	M2	00000000		01220	CABLE ASSY – VIDEO (DC1 to S11)	1
						Containing:	
—	J2	M2	107528	OSM531-3	16179	CONNECTOR, Cable-Mount, SMA male	1
—		M2	107390	8629	16428	CABLE, Coaxial, 50Ω, RG-188/U	A/R
—		M2	108188	RT876 1/8 BLK	06090	TUBING, Heat-Shrink, 1/8 dia. x 1/2	1
31	W3	S	948678		01220	CABLE ASSY – RF OUTPUT	1
						Containing:	
—	J3	S	107070	OSM201-1A	16179	CONNECTOR, Cable-Mount, SMA male	1
—	J14	S	113248	3004-7941	26805	CONNECTOR, Panel-Mount, N female	1
—		S	107071	UT-141ATP	93306	CABLE, Coaxial, 50Ω semi-rigid (0.141 dia.)	A/R
32	Y1	F	962315	S09-2064M	24539	OSCILLATOR, 1.65–4.25 GHz	1
						Includes:	
—	J4	G				CONNECTOR, SMA Female	1
33	Y1VR1	G				DIODE, Zener, ≈ 15 V (value selected by mfr.)	1
34		H	105800	TM-1S4M	06383	ANCHOR, Strap, nylon no. 4	1
35		H	105797	TM-1S6M	06383	ANCHOR, Strap, nylon no. 6	5
36			928642		01220	BAR, Mounting, left bottom	1
37			92864201		01220	BAR, Mounting, left top	1
38			928643		01220	BAR, Mounting, right bottom	1
39			92864301		01220	BAR, Mounting, right top	1
40			104458	5133-12	79136	CLIP, E-Ring	2
41			922255		01220	HEATSINK, Transistor	1
42		M7/M7A	934188		01220	INSULATOR, Circuit Board	1
43			94800407		01220	KNOB ASSEMBLY, RF Level	1
44			100509	1416-4	83330	LUG, Ground, internal tooth no. 4	1
45			104262	1497	83330	LUG, Ground, 3/8	1
46			108110	MK77-2	04713	MOUNTING KIT, Transistor	2
						Includes:	
—						WASHER, Metal, special	1
—						WASHER, Insulating, mica	1
47			104629	N-1A	95146	NUT, Knurled, 1/4-40	4
47		M3/M3A	104629	N-1A	95146	NUT, Knurled, 1/4-40	1
47		M7/M7A	104629	N-1A	95146	NUT, Knurled, 1/4-40	1
48			100941	511-041800-00	78189	NUT, Kep, 4-40	2
49				Supplied with S9,S10, S12	95146	NUT, 1/4-40	3
49				Supplied with S11	09353	NUT, 1/4-40	1
49		M3/M3A		Supplied with S13	95146	NUT, 1/4-40	1
49		M7/M7A		Supplied with S19	95146	NUT, 1/4-40	1
50				Supplied with R4–R6	95146	NUT, 1/4-32	3
51				Supplied with J7	02660	NUT, 3/8-32	1
52				Supplied with CP1 or W3	15907 26805	NUT, 5/8-24	1

Table 7-3. Model 5013-2 RF Plug-in Chassis Parts List (Continued)

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION	QTY.
53		S	915092		01220	PANEL ASSEMBLY, Front	1
54			104515	51-18-106-24	994222	Order with: HOLDER, Captive Screw	1
55		S	96203894		01220	PLATE, Model	1
56			100617	50x7/64 NI BRS	84841	RIVET, Model Plate Mounting	2
53		M2	915044		01220	PANEL ASSEMBLY, Front	1
54			104515	51-18-106-24	94222	Order with: HOLDER, Captive Screw	1
55		M2	96203895		01220	PLATE, Model	1
56			100617	50x7/64 NI BRS	84841	RIVET, Model Plate Mounting	2
53		M3/M3A	91504301		01220	PANEL ASSEMBLY, Front	1
54			104515	51-18-106-24	94222	Order with: HOLDER, Captive Screw	1
55		S	96203894		01220	PLATE, Model	1
55		M2	96203895		01220	PLATE, Model	1
56			100617	50x7/64 NI BRS	84841	RIVET, Model Plate Mounting	2
53		M7/M7A	91504302		01220	PANEL ASSEMBLY, Front	1
54			104515	51-18-106-24	94222	Order with: HOLDER, Captive Screw	1
55		S	96203894		01220	PLATE, Model	1
55		M2	96203895		01220	PLATE, Model	1
56			100617	50x7/64 NI BRS	84841	RIVET, Model Plate Mounting	2
57			92201101		01220	PANEL, Rear	1
58			922016		01220	PLATE, Dial Scale Mounting	2
59			922488		01220	PLATE, Oscillator Mounting	1
60			922120		01220	PLATE, Potentiometer/Connector Mounting	1
61			934017		01220	SCALE, Frequency Dial, 1.65—4.25 GHz	1
62			104516	51-18-108-24	94222	SCREW, Knurled, captive	1
63			928018		01220	SCREW, Knurled, dial scale	2
64			104609		01220	SCREW, Fillister Head Phillips, 6-32 x 5/16	2
65			10072004	MS24693C2	96906	SCREW, Flat Head Phillips, 4-40 x 1/4, 100°	2
66			10073103	MS24693C23	96906	SCREW, Flat Head Phillips, 6-32 x 3/16, 100°	4
67			10073104	MS24693C24	96906	SCREW, Flat Head Phillips, 6-32 x 1/4, 100°	4
68			10073105	MS24693C25	96906	SCREW, Flat Head Phillips, 6-32 x 5/16, 100°	4
69			104601		01220	SCREW, Oval Head Phillips, 6-32 x 5/16, 82°	4
70			10062503	MS51957-2	96906	SCREW, Pan Head Phillips, 2-56 x 3/16	2
71			10062602	MS51957-11	96906	SCREW, Pan Head Phillips, 4-40 x 1/8	1
72			10062604	MS51957-13	96906	SCREW, Pan Head Phillips, 4-40 x 1/4	2
73			10062605	MS51957-14	96906	SCREW, Pan Head Phillips, 4-40 x 5/16	4
74			10063203	MS51957-25	96906	SCREW, Pan Head Phillips, 6-32 x 3/16	3
75			10063205	MS51957-27	96906	SCREW, Pan Head Phillips. 6-32 x 5/16	4
76		S	10063203	MS51957-25	96906	SCREW, Pan Head Phillips, 6-32 x 3/16	2
77		M7/M7A	10063214	MS51957-33	96906	SCREW, Pan Head Phillips, 6-32 x 7/8	2
78		M7/M7A	104563	8583	83330	SPACER, Hexagonal, no. 6 x 1/2	2
79			100753	SST-1	06383	STRAP, Cable Tie, nylon	5
80			108188	RT876 1/8 BLK	06090	TUBING, Heat-Shrink, 1/8 dia. x 1/2	2
81			104463	2160	83330	WASHER, Flat Fiber, no. 6	8
82		M7/M7A	104463	2160	83330	WASHER, Flat Fiber, no. 6	2
83				Supplied with J7	02660	WASHER, Lock, internal tooth, 3/8	1
84				Supplied with CP1 or W3	15907 26805	WASHER, Lock, internal tooth, 5/8	1
85			100661	MS35337-77	96906	WASHER, Lock, split, no. 2	2
86		M7/M7A	100712	MS35338-136	96906	WASHER, Lock, split, no. 6	2
87				Supplied with S9,S10, S12	95146	WASHER, Switch Locating	3
87				Supplied with S11	95146	WASHER, Switch Locating	1
87		M3/M3A		Supplied with S13	95146	WASHER, Switch Locating	1
87		M7/M7A		Supplied with S19	95146	WASHER, Switch Locating	1

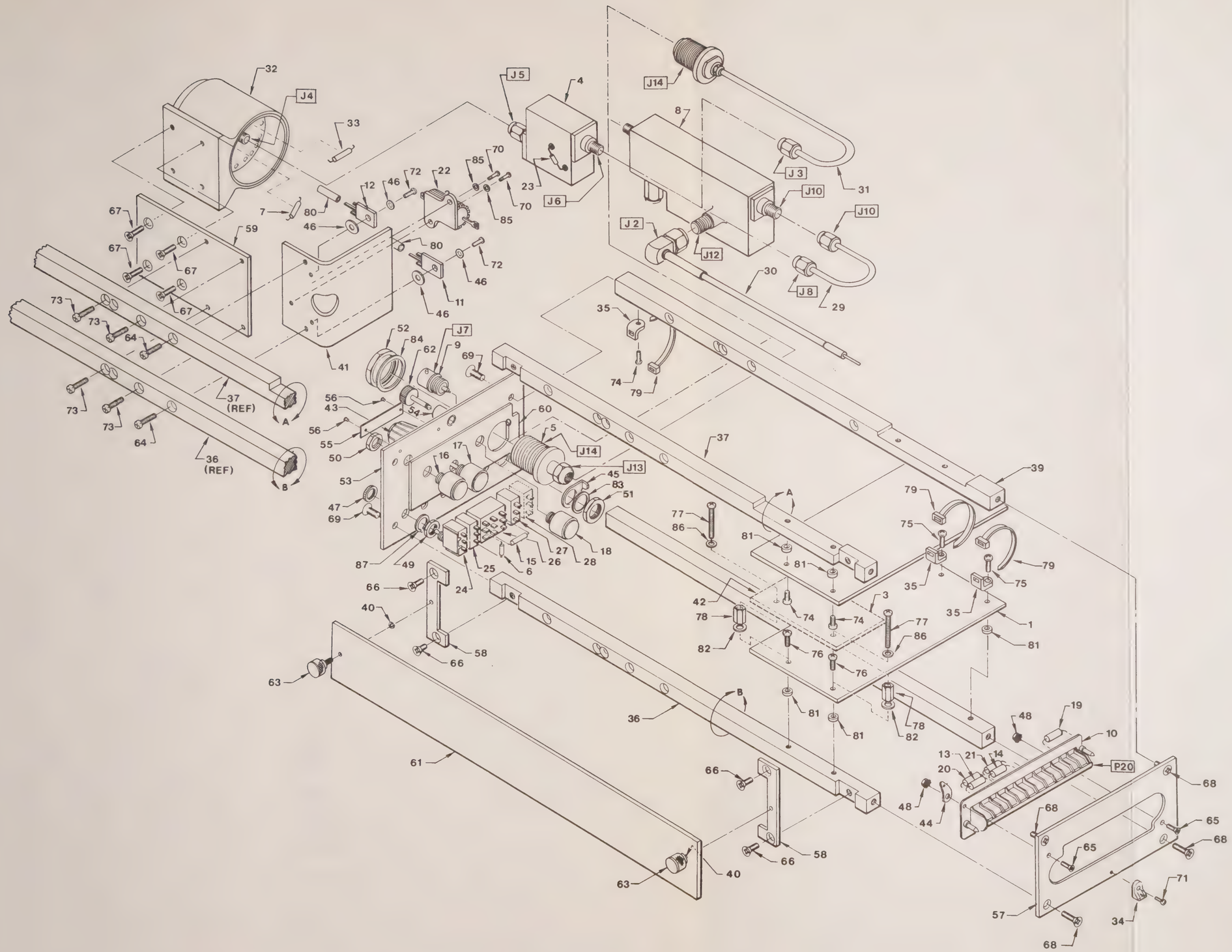
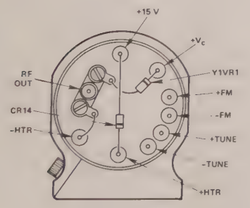


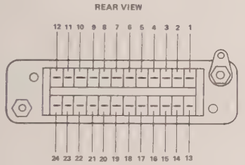
Figure 7-1. Model 5013-2 RF Plug-in Illustrated Parts Breakdown

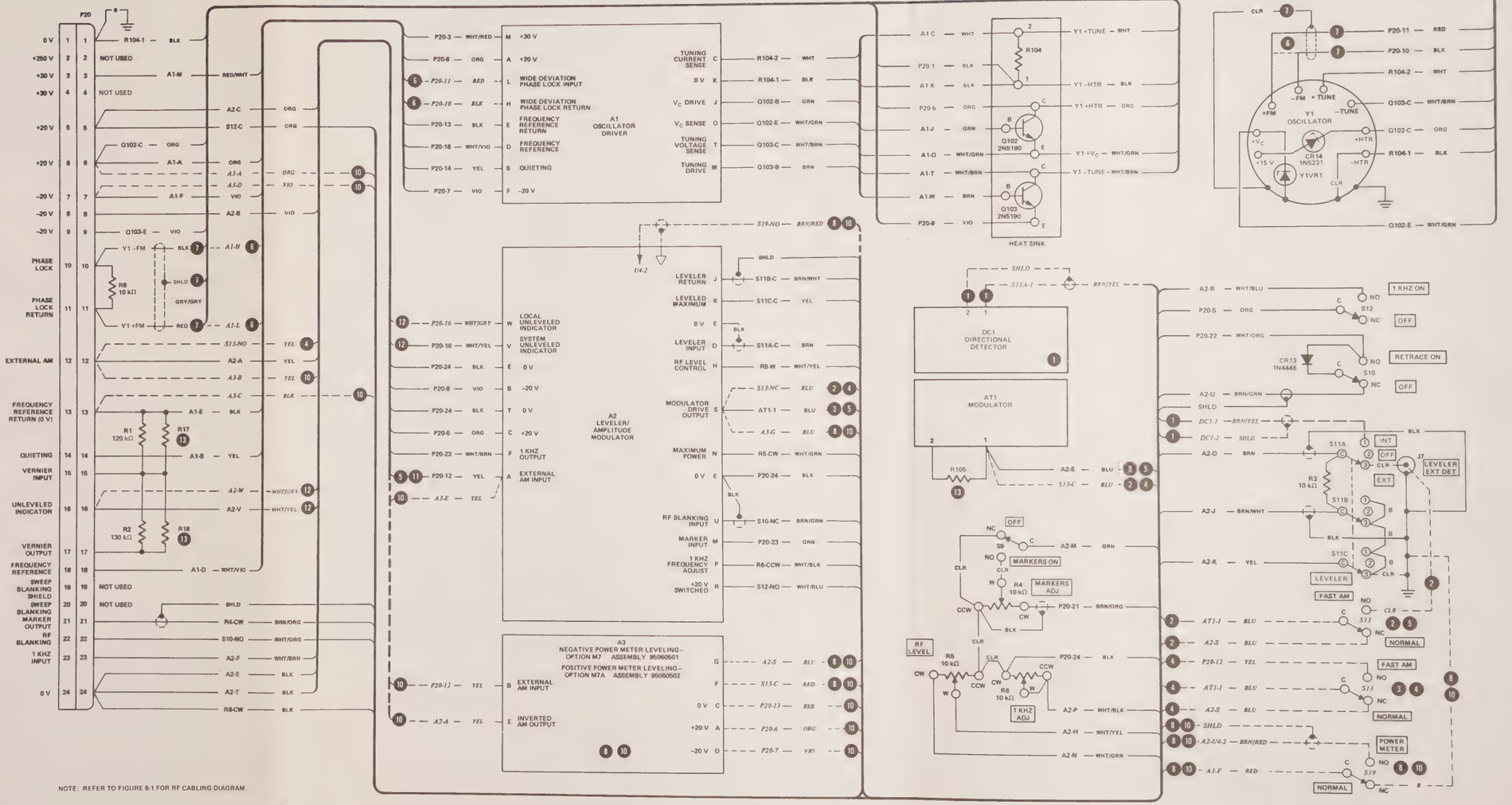
WIRE COLOR LEGEND		
ABBREVIATION	WIRE NUMBER	WIRE TYPE WIRE COLOR
BLK	0	BLACK
BRN	1	BROWN
RED	2	RED
ORG	3	ORANGE
YEL	4	YELLOW
GRN	5	GREEN
BLU	6	BLUE
VIO	7	VIOLET
GRY	8	GREY
WHT	9	WHITE
B		BARE BUS WIRE
CLR	99	BARE BUS WIRE/ CLEAR SLEEVING
WHT/BLK	90	WHITE/BLACK STRIPE
WHT/BRN	91	WHITE/BROWN STRIPE
WHT/RED	92	WHITE/RED STRIPE
WHT/ORG	93	WHITE/ORANGE STRIPE
WHT/YEL	94	WHITE/YELLOW STRIPE
WHT/GRN	95	WHITE/GREEN STRIPE
WHT/BLU	96	WHITE/BLUE STRIPE
WHT/VIO	97	WHITE/VIOLET STRIPE
WHT/GRY	98	WHITE/GREY STRIPE
BRN/BRN	110	BROWN COAXIAL CABLE
BRN/RED	120	BROWN COAXIAL CABLE/RED STRIPE
BRN/ORG	130	BROWN COAXIAL CABLE/ORANGE STRIPE
BRN/YEL	140	BROWN COAXIAL CABLE/YELLOW STRIPE
BRN/GRN	150	BROWN COAXIAL CABLE/GREEN STRIPE
BRN/BLU	160	BROWN COAXIAL CABLE/BLUE STRIPE
BRN/VIO	170	BROWN COAXIAL CABLE/VIOLET STRIPE
BRN/GRY	180	BROWN COAXIAL CABLE/GREY STRIPE
BRN/WHT	190	BROWN COAXIAL CABLE/WHITE STRIPE
GRY/GRY	88	GREY SHIELDED CABLE

NOTES

1. ADD FOR OPTION M2
2. ADD FOR OPTION M3
3. DELETE FOR OPTION M3
4. ADD FOR OPTION M3A
5. DELETE FOR OPTION M3A
6. ADD FOR OPTION M6
7. DELETE FOR OPTION M6
8. ADD FOR OPTION M7
9. DELETE FOR OPTION M7
10. ADD FOR OPTION M7A
11. DELETE FOR OPTION M7A
12. NOT USED IN CURRENT PRODUCTION VERSIONS
13. COMPONENT VALUE SELECTED AT TEST







NOTE: REFER TO FIGURE 6-1 FOR RF CABLING DIAGRAM

Figure 7-2. Model 5013-2 RF Plug-in Schematic/Wiring Diagram

SECTION VIII

OSCILLATOR DRIVER

8-1. GENERAL

This section contains circuit theory, trouble isolation information, a replaceable parts list, and a schematic diagram with parts location and test point information for Oscillator Driver Printed Circuit Board Assembly A1. Overall plug-in and microwave component operating theory for the RF plug-in containing A1 may be found in Section VI, with the plug-in chassis interconnect wiring diagram and parts list in Section VII.

8-2. THEORY OF OPERATION (Figure 8-1)

The YIG-tuned oscillator used in the plug-in unit has a tuning curve which is inherently linear, and requires operating and tuning drive currents as high as 800 milliamperes. The oscillator driver board is used to provide operating power and to convert the frequency reference voltage from the mainframe into current drive for the main tuning coil in the oscillator. The oscillator driver also contains protective circuitry for the oscillator element and tuning circuits.

8-2.1 Operating Power

A programmable remote-sensing power supply comprising an integrated-circuit error amplifier and pass transistor (with several protective devices) provides operating power for the active oscillator element in the oscillator module. (Operating power for Gunn-diode oscillators is abbreviated V_b. Depending upon manufacturer, operating power for transistor oscillators is abbreviated V_c or V_b.) The required V_b/V_c level is determined by the output of operational amplifier A1U7, based upon the levels of the three inputs to A1U7:

1. V_b/V_c sensing feedback from heatsink-mounted regulator transistor Q102. The voltage level sensing feedback is coupled through terminal O of A1 and the voltage divider comprising resistors A1R36/R37 and A1R34/R35 into the inverting summing junction of A1U7.

2. A programming input from tuning summer/inverter A1U1 through A1R45 into the inverting summing junction of A1U7.

3. An offsetting bias from a stable 6.2 volt reference (A1VR7) into the non-inverting summing junction of A1U7 through A1R33.

These inputs are summed together in A1U7, which delivers a positive-polarity base current drive output for regulator transistor Q102 mounted to the chassis heatsink. The regulator transistor, in turn, provides operating voltage from the plus 20 or plus 30 volt mainframe power supply for the oscillator module. The oscillator requires a stable, well-regulated voltage source; different oscillator modules, though bearing the same manufacturer's model number, will probably require different operating voltages. This voltage is usually specified on the nameplate label or on a test data sheet supplied with the module. The range of voltages varies from less than 5 to more than 15. (When oscillators which require voltages below 6.2 volts are used, resistor A1R46 forms a voltage divider with A1R33 to reduce the output of A1U7 below its normal minimum of 6.2 volts.)

Capacitor A1C14 filters out short-term voltage changes and perturbations to maintain low noise in the V_b/V_c output.

8-2.2 Overvoltage and Reverse Polarity Protection

The operating voltage at the oscillator V_b/V_c terminals, in addition to being coupled into the error amplifier, is also fed to the protective circuitry of the oscillator driver.

The V_b/V_c level is limited to the reverse-avalanche level of Zener diode A1VR9; this diode is selected at test for a voltage approximately 1.5 volts above the highest level required by the oscillator. Should the V_b /V_c reach this limit, through malfunction of A1U7 or test connection error, current will flow through A1VR9 and A1R38 to ground. The voltage developed across A1R38 will fire silicon-controlled rectifier (SCR) A1Q8 to reduce the output of A1U7 to zero and turn off regulator transistor Q102. The SCR will not open until mainframe power is turned off.

In the event that Q102 suffers an emitter-collector short circuit, diode A1CR8 prevents the full power supply voltage from damaging the oscillator: current is conducted through A1CR8 and A1VR9, firing SCR A1Q8. The resulting short circuit to ground will drive the mainframe power supply into its current-limit mode and reduce the voltage applied to the oscillator to less than one-half volt.

Should the V_b/V_c level become negative, through malfunction of a component or connection error during test or troubleshooting operations, diode A1VR9 will conduct all current through A1R38 to ground.

The oscillator module itself is fitted with a factory-selected Zener diode for further overvoltage or reverse-polarity protection; this diode is internal in some oscillators and visible on external terminals in others. This diode prevents destruction of the oscillator element in the event of a malfunction in regulator Q102 by acting as a short circuit and driving the mainframe power supply into current limiting.

8-2.3 Programming

In order to obtain optimum oscillator performance in some plug-ins, the operating voltage is programmed over the swept frequency range.

8-2.3.1 **GUNN DIODE OSCILLATORS.** In Gunn diode oscillator modules, programming is utilized to obtain the highest output power over the widest frequency range possible. These Gunn-diode oscillators require a higher low-frequency V_b than the V_b used at the high frequencies to achieve optimum power output over the band.

A portion of the inverted (zero to plus 10 volts) tuning voltage output of summer/inverter A1U1 is coupled through resistor A1R45 to the inverting summing junction of A1U7. At the lowest operating frequency, the frequency reference input voltage is near zero; consequently, the output of A1U1 is zero. As the tuning voltage from the mainframe increases (to a maximum of minus 10 volts), the output of A1U1 increases (to a maximum of plus 10 volts). Current is coupled through A1R45 into the inverting summing junction of A1U7, which reduces the output of A1U7 to Q102. Consequently, the V_b level is reduced as the tuning drive of the oscillator increases. Diode A1CR12 prevents the output of A1U1 from going negative in response to a momentary pulse or inadvertent connection of a positive-going *external tune* signal. A negative output from A1U1 could possibly increase the programmed V_b to excessive levels.

8-2.3.2 **TRANSISTOR OSCILLATORS.** Programming is used with some YIG-tuned transistor oscillators to reduce the harmonic content of the oscillator's output signal. To accomplish this, it is necessary to increase the V_c with increasing V_t.

The programming resistor is connected directly to the negative-going frequency reference input of A1U1. As this negative input to the inverting summing junction of A1U7 is increased, the positive output of A1U7 rises to increase the V_c at the oscillator terminals. (Diode A1CR12 is not used with transistor oscillators.)

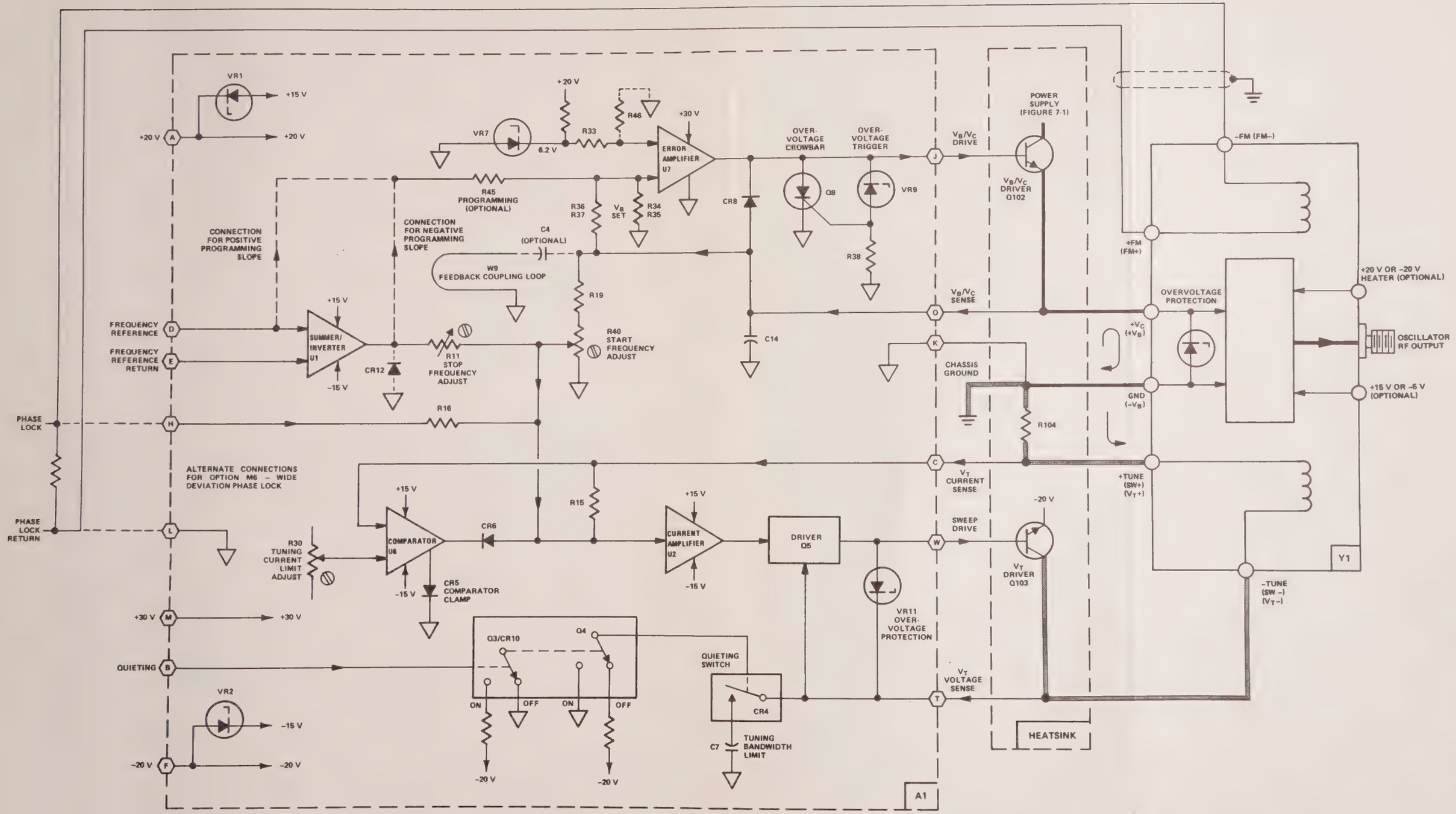


Figure 8-1. Oscillator Driver Simplified Schematic Diagram

8-2.4 Frequency Tuning

This frequency reference output of the mainframe is differentially coupled to operational amplifier A1U1 of the oscillator driver; this device is connected as an inverting current summer operating with a voltage gain of minus 1. The differential connection assures that any common mode noise — unwanted signals appearing on the frequency reference input and on the return — are ignored. This considerably reduces the effect of line-frequency and other extraneous conducted or radiated emissions upon the output frequency of the driven oscillator.

8-2.4.1 **TUNING CURRENT AMPLIFIER.** Operational amplifier A1U2, driver transistor A1Q5, and tuning current regulator transistor Q103 form a voltage-to-current amplifier which drives the main tuning coil in the oscillator. The amplifier is capable of delivering currents greater than 1 Ampere, and operates in a closed loop. Tuning current flows from the return of the minus 20 volt supply through tuning current sense resistor R104 and transistor Q103 to the +TUNE (or SW+ or V_t+) terminal of the oscillator; current flow continues through the tuning coil to the - 20 volt supply.

The voltage developed across sense resistor R104 is applied as feedback to tuning amplifier A1U2. The current through the tuning coil (and consequently the operating frequency of the oscillator) is determined by the algebraic sum of the current values into the summing junction of A1U2:

1. Start frequency (dc offset) from the V_b/V_c supply through variable resistor A1R40
2. Stop frequency (upper dc limit) from the inverted tuning output of A1U1 through variable resistor A1R11
3. Tuning coil current-sense feedback through resistor A1R15.

8-2.4.2 **TUNING CURRENT LIMIT.** If the sensed tuning current exceeds a predetermined limit set by variable resistor A1R30, comparator A1U6 will change state and hold the tuning current amplifier to its maximum allowable value. This action prevents the oscillator from being driven beyond its normal operating band by transients or excessive external FM input levels. Some Gunn-diode oscillator modules may be driven into a "locked" mode where the RF output is reduced to zero. In that case, the circuitry may be reset by turning off the mainframe power switch, waiting about 15 seconds, then turning the power back on. The tuning current limit is generally not needed with YIG-tuned transistor oscillators; the circuit is disabled by leaving out calibration resistors A1R28 and A1R29.

8-2.4.3 **QUIETING.** When the sweeper is operated in a non-swept mode — CW or manual sweep — a quieting input from the mainframe activates quieting switch A1Q3/A1CR10/A1Q4/A1CR4 to connect capacitor A1C7 from the output of tuning current driver A1Q5 to ground. This reduces the tuning bandwidth of the amplifier to less than 10 hertz, reducing incidental noise and residual FM in the RF output.

The mainframe quieting input at terminal B of A1 is approximately 4.5 to 5 volts positive (a digital "1"). Current from the quieting input is conducted through resistor A1R4 and diode A1CR10 to ground. The voltage level at the base of A1Q3 becomes plus 600 millivolts, the forward voltage drop across A1CR10. This turns A1Q3 off, and the increased negative level at the base of A1Q4 turns it on. Diode A1CR4, which had been back-biased by the negative voltage at its anode through A1R8, becomes forward biased and switches A1C7 into the tuning output of A1Q5.

8-2.4.4 **FM TUNING INPUTS.** An external frequency-modulation signal can be coupled through the mainframe directly to the auxiliary YIG tuning coil in the oscillator. The FM coils used in the various oscillator types have a resistance ranging from 500 milliohms to one ohm, and tuning sensitivities from 150 to 450 kilohertz per milliampere. The output frequency of the oscillator is reduced with negative

drive and increased with positive drive, to the band-edge limits. When the phase lock input is connected as a wide tuning input to terminal H of A1, the sensitivity to external inputs is 46 megahertz per volt to the band edges. Positive inputs increase the frequency.

8-3. TROUBLE ISOLATION

Figure 8-2 is an aid to trouble isolation in the oscillator driver components. This table should be used with the supporting information listed below:

1. The circuit descriptions and simplified schematic diagram in Paragraph 8-2 of this section.

2. Schematic diagram and parts location drawing Figure 8-3 at the end of this section; this drawing includes basing diagrams of the multi-lead semiconductor devices used on A1.

Begin trouble isolation procedures with Figure 5-2 of Section V before attempting trouble isolation to the component level on A1.

8-4. REPLACEABLE PARTS LIST

Table 8-2 in this section contains a list of replaceable parts for Oscillator Driver Assembly A1. Replaceable parts lists for the chassis assembly are found in Section VII. Replaceable parts lists for leveler/amplitude modulator subassembly A2 and for power meter leveling subassembly A3 are found in Section IX.

8-4.1 Ordering Replacement Parts

The majority of the electronic parts used in construction of the A1 board assembly are standard distributor items, and should be available locally. To order special replacement parts and parts which are not otherwise obtainable, write to Systron-Donner Corporation at the address shown at the front of this manual, or contact your local Scientific Devices office.

Be sure to include the model number and serial number of the unit for which parts are required. Please order by Systron-Donner part number; also include the A1 reference designator where applicable.

8-4.2 Explanation of Columns

8-4.2.1 **FIG NO.** This column references the figure number of the drawings in which the part can be located.

8-4.2.2 **REF. DESIG.** Electronic parts are listed in sequence by reference designation and may be located on the schematic diagram by this designator.

8-4.2.3 **USE CODE.** An entry in this column indicates that the part may not be found in all units because it is part of an option, a part replaced when an option is ordered, or an alternate part. The size or electrical value of a component coded "B" is determined by its use in the RF plug-in, and is listed in the chassis parts list. No size or value is shown on the parts list for A1 (refer to Table 7-3, Section VII). The component size or electrical value of a component coded "T" is chosen by test as part of a calibration procedure.

8-4.2.4 SYSTRON-DONNER PART NUMBER. All standard parts manufactured by Systron-Donner or manufactured to Systron-Donner specifications are listed in this column, but not in the *MFR'S PART NUMBER* column. All other purchased parts which have been assigned Systron-Donner part numbers are also listed in this column. These part numbers must be used when ordering parts.

8-4.2.5 MFR'S PART NUMBER. Commercially-available parts not manufactured by Systron-Donner or to Systron-Donner specifications are listed in this column. Insofar as possible, these part numbers are complete. For best results, always include a complete part description as well as the listed manufacturer's part number when ordering replacement parts from manufacturers or distributors.

8-4.2.6 MFR. CODE. The five-digit Federal Manufacturers Codes, as listed in Cataloging Handbooks H4-1 and H4-2, are listed in this column. These codes and corresponding manufacturers are listed in Table 8-1.

8-4.2.7 DESCRIPTION. Descriptions of component parts of subassemblies are indented to indicate the parts comprising each subassembly.

8-5. SCHEMATIC DIAGRAMS

Figure 8-3 is the A1 board parts location drawing and schematic diagram. Schematic diagrams for the A2 and A3 boards are found in Section IX; the chassis wiring diagram is in Section VI.

Table 8-1. Manufacturers' Codes

CODE	NAME
01121	Allen Bradley Co., Milwaukee WI 53204
01220	Systron-Donner Corporation, Microwave Division, Van Nuys CA 91411
01686	AMF, Inc., RCL Electronics Division, Manchester NH 03102
03508	General Electric Co., Semiconductor Products Dept., Auburn NY 13021
04713	Motorola, Inc., Semiconductor Products Group, Phoenix AZ 85008
12969	Unitrode Corporation, Watertown MA 02172
24546	Corning Glass Works, Bradford PA 16701
27014	National Semiconductor Corp., Santa Clara CA 95051
31433	Union Carbide Corp., Components Dept., Greenville SC 29606
56289	Sprague Electric Co., North Adams MA 01247
71002	Birnbach Co., Inc., Freeport LI NY 11520
72136	Electro-Motive Manufacturing Co., Inc., Subsidiary of International Electronics Corp., Florence SC 29501
72982	Erie Technological Products, Erie PA 16512
80294	Bourns, Inc., Instrument Division, Riverside CA 92506
99942	Centralab Electronics, Division of Globe-Union, Inc., Milwaukee WI 53201

OSCILLATOR Y1 TERMINAL NOMENCLATURE CROSS-REFERENCE

MANUFACTURER	Systron-Donner (Early)	Systron-Donner (Late)	Varian (Early)	Varian (Late)	Avantek	Watkins-Johnson (Late)	OmniYig	Term Used in Fig. 8-2
FUNCTION:								
Operating Power	6	V_b+	V_B+	V_B+	$+V_C$ or +15V	$+V_{DC}$	6	$+V_b$
Power Return	5	GND	V_B-	GND	Not Marked	GND	5	Chassis
Main Tuning Coil	1	TUN+	SW+	SW+	+TUNE	COIL+	1	+TUNE
Main Coil Return	2	TUN–	SW–	SW–	–TUNE	COIL–	2	–TUNE
FM Tuning Coil	7	FM+	FM+	FM+	+FM	FM Coil+	4	+FM
FM Coil Return	8	FM–	FM–	FM–	–FM	FM Coil–	3	–FM
Heater	3	HTR	Not Used	Not Used	HTR	Not Used	8	+HTR
Heater Return	4	HTR	Not Used	Not Used	HTR	Not Used	7	–HTR
Auxiliary Operating Power	Not Used	Not Used	Not Used	Not Used	+15V or –5 V	Not Used	Not Used	Auxiliary Power

Figure 8-2. Oscillator Driver A1 Troubleshooting Diagram (Sheet 1)

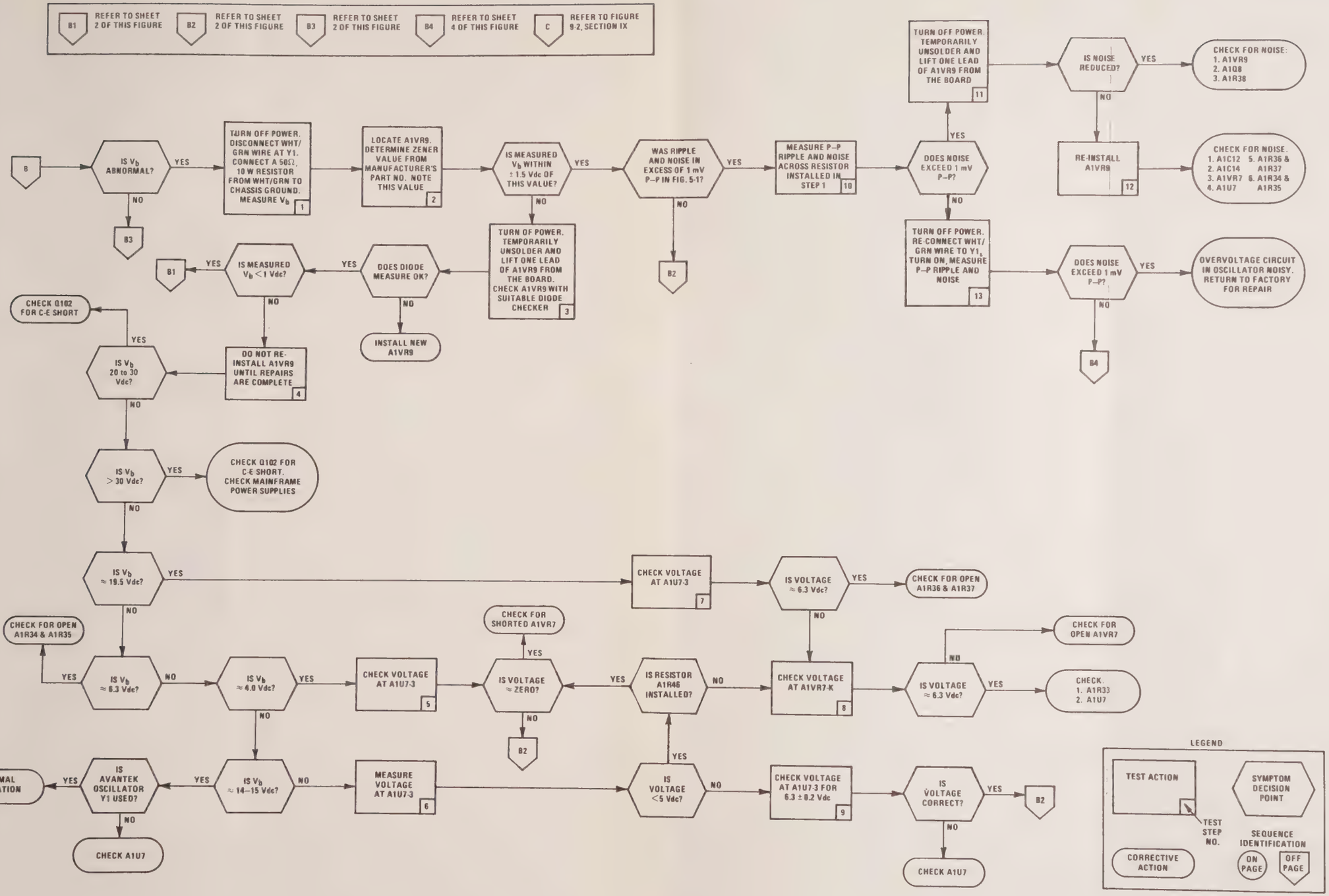

B1 REFER TO SHEET 2 OF THIS FIGURE
B2 REFER TO SHEET 2 OF THIS FIGURE
B3 REFER TO SHEET 2 OF THIS FIGURE
B4 REFER TO SHEET 4 OF THIS FIGURE
C REFER TO FIGURE 9-2, SECTION IX
B
IS Vb ABNORMAL?
YES
NO
B3
TURN OFF POWER. DISCONNECT WHT/GRN WIRE AT Y1. CONNECT A 50Ω, 10 W RESISTOR FROM WHT/GRN TO CHASSIS GROUND. MEASURE Vb 1
LOCATE A1VR9. DETERMINE ZENER VALUE FROM MANUFACTURER'S PART NO. NOTE THIS VALUE 2
IS MEASURED Vb WITHIN ± 1.5 Vdc OF THIS VALUE?
TURN OF POWER. TEMPORARILY UNSOLDER AND LIFT ONE LEAD OF A1VR9 FROM THE BOARD. CHECK A1VR9 WITH SUITABLE DIODE CHECKER 3
DOES DIODE MEASURE OK?
INSTALL NEW A1VR9
IS MEASURED Vb < 1 Vdc?
B1
DO NOT RE-INSTALL A1VR9 UNTIL REPAIRS ARE COMPLETE 4
CHECK Q102 FOR C-E SHORT
IS Vb 20 to 30 Vdc?
IS Vb > 30 Vdc?
CHECK Q102 FOR C-E SHORT. CHECK MAINFRAME POWER SUPPLIES
IS Vb ≈ 19.5 Vdc?
CHECK FOR OPEN A1R34 & A1R35
IS Vb ≈ 6.3 Vdc?
IS Vb ≈ 4.0 Vdc?
CHECK VOLTAGE AT A1U7-3 5
CHECK FOR SHORTED A1VR7
IS VOLTAGE ≈ ZERO?
B2
IS Vb ≈ 14–15 Vdc?
MEASURE VOLTAGE AT A1U7-3 6
NORMAL OPERATION
IS AVANTEK OSCILLATOR Y1 USED?
CHECK A1U7
WAS RIPPLE AND NOISE IN EXCESS OF 1 mV P–P IN FIG. 5-1?
B2
MEASURE P–P RIPPLE AND NOISE ACROSS RESISTOR INSTALLED IN STEP 1 10
TURN OFF POWER. TEMPORARILY UNSOLDER AND LIFT ONE LEAD OF A1VR9 FROM THE BOARD 11
DOES NOISE EXCEED 1 mV P–P?
TURN OFF POWER. RE-CONNECT WHT/GRN WIRE TO Y1. TURN ON. MEASURE P–P RIPPLE AND NOISE 13
IS NOISE REDUCED?
CHECK FOR NOISE: 1. A1VR9 2. A1Q8 3. A1R38
RE-INSTALL A1VR9 12
CHECK FOR NOISE. 1. A1C12 2. A1C14 3. A1VR7 4. A1U7 5. A1R36 & A1R37 6. A1R34 & A1R35
DOES NOISE EXCEED 1 mV P–P?
OVERVOLTAGE CIRCUIT IN OSCILLATOR NOISY. RETURN TO FACTORY FOR REPAIR
B4
IS RESISTOR A1R46 INSTALLED?
CHECK VOLTAGE AT A1VR7-K 8
IS VOLTAGE ≈ 6.3 Vdc?
CHECK FOR OPEN A1VR7
CHECK: 1. A1R33 2. A1U7
CHECK VOLTAGE AT A1U7-3 7
IS VOLTAGE ≈ 6.3 Vdc?
CHECK FOR OPEN A1R36 & A1R37
IS VOLTAGE <5 Vdc?
CHECK VOLTAGE AT A1U7-3 FOR 6.3 ± 0.2 Vdc 9
IS VOLTAGE CORRECT?
B2
CHECK A1U7
LEGEND
TEST ACTION
TEST STEP NO.
SYMPTOM DECISION POINT
SEQUENCE IDENTIFICATION
ON PAGE
OFF PAGE
CORRECTIVE ACTION

Figure 8-2. Oscillator Driver A1 Troubleshooting Diagram (Sheet 2)

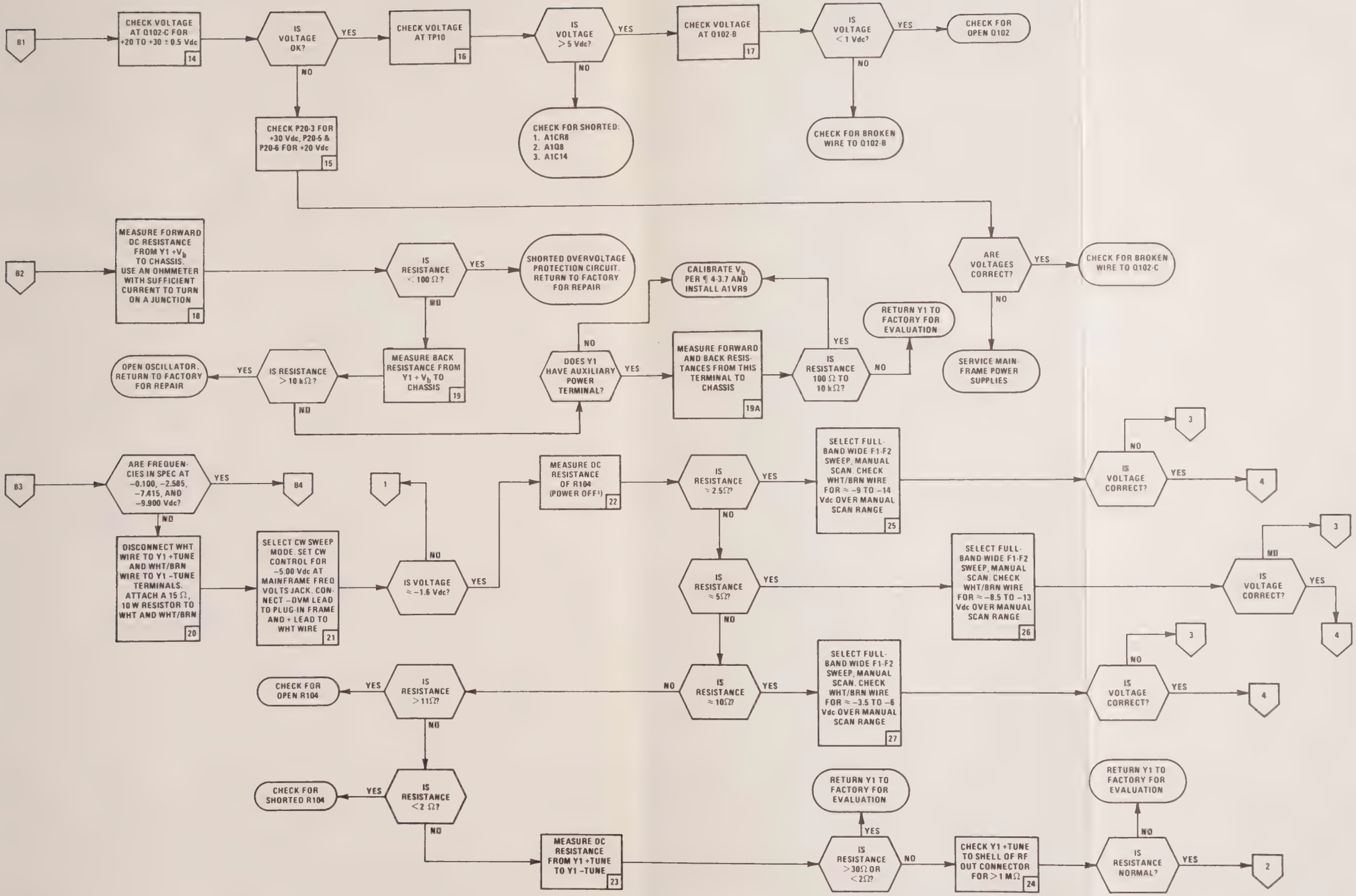


Figure 8-2. Oscillator Driver A1 Troubleshooting Diagram (Sheet 3)

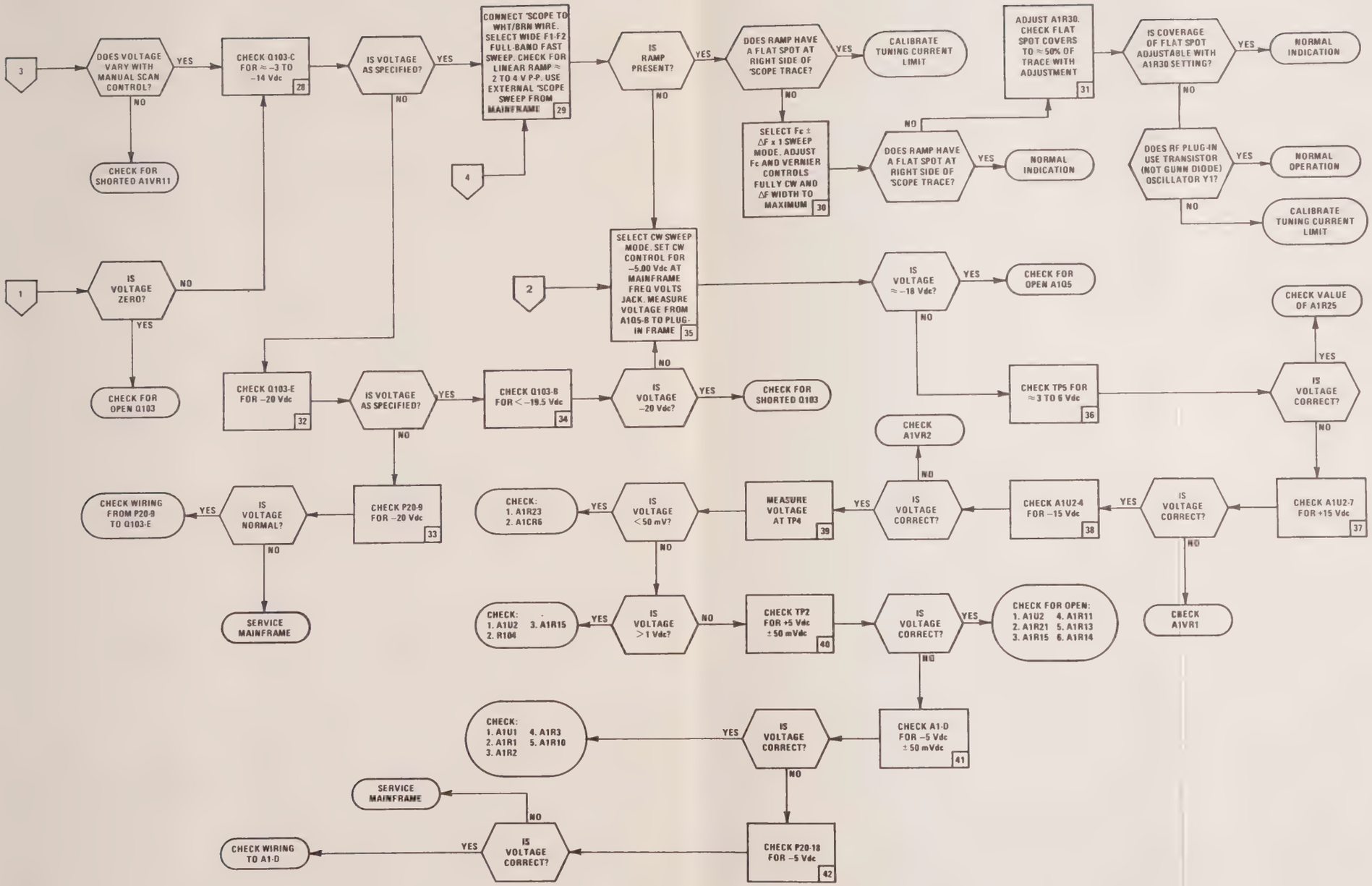


Figure 8-2. Oscillator Driver A1 Troubleshooting Diagram (Sheet 4)

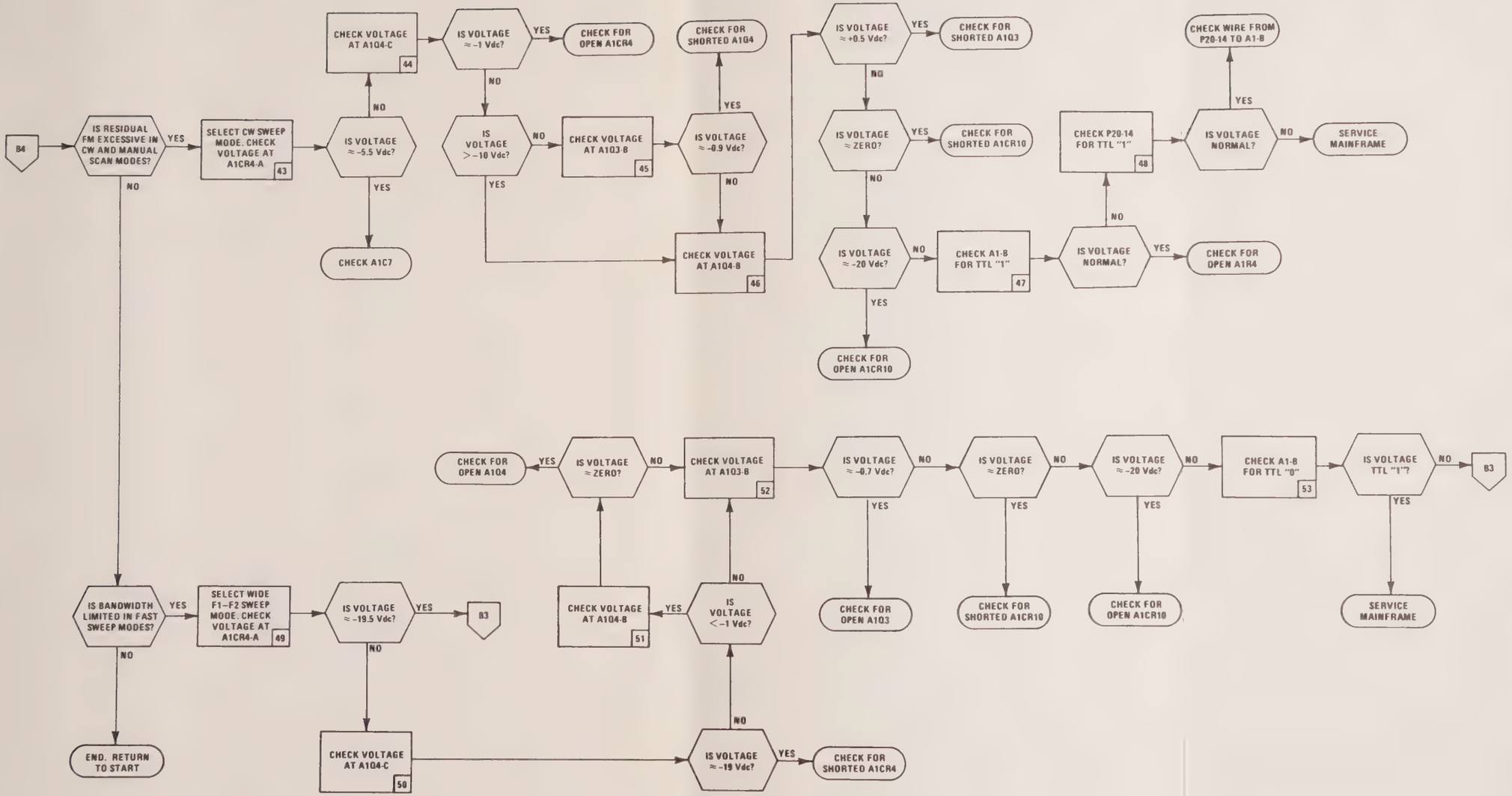


Figure 8-2. Oscillator Driver A1 Troubleshooting Diagram (Sheet 5)

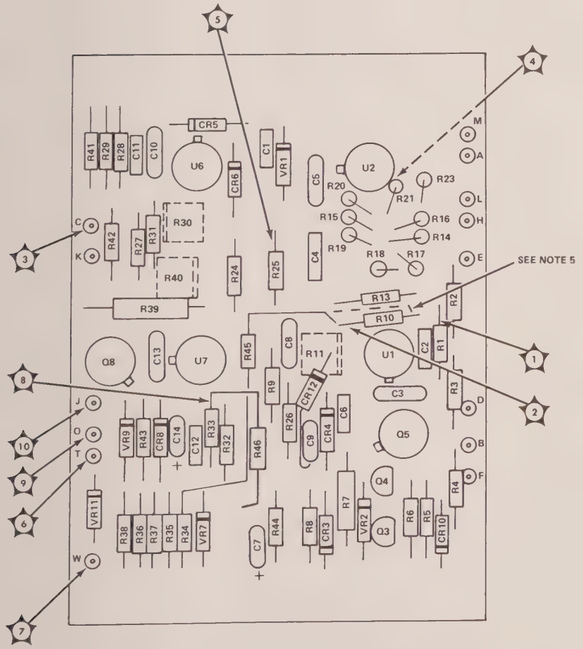
Table 8-2. Oscillator Driver Assembly A1 Replaceable Parts List

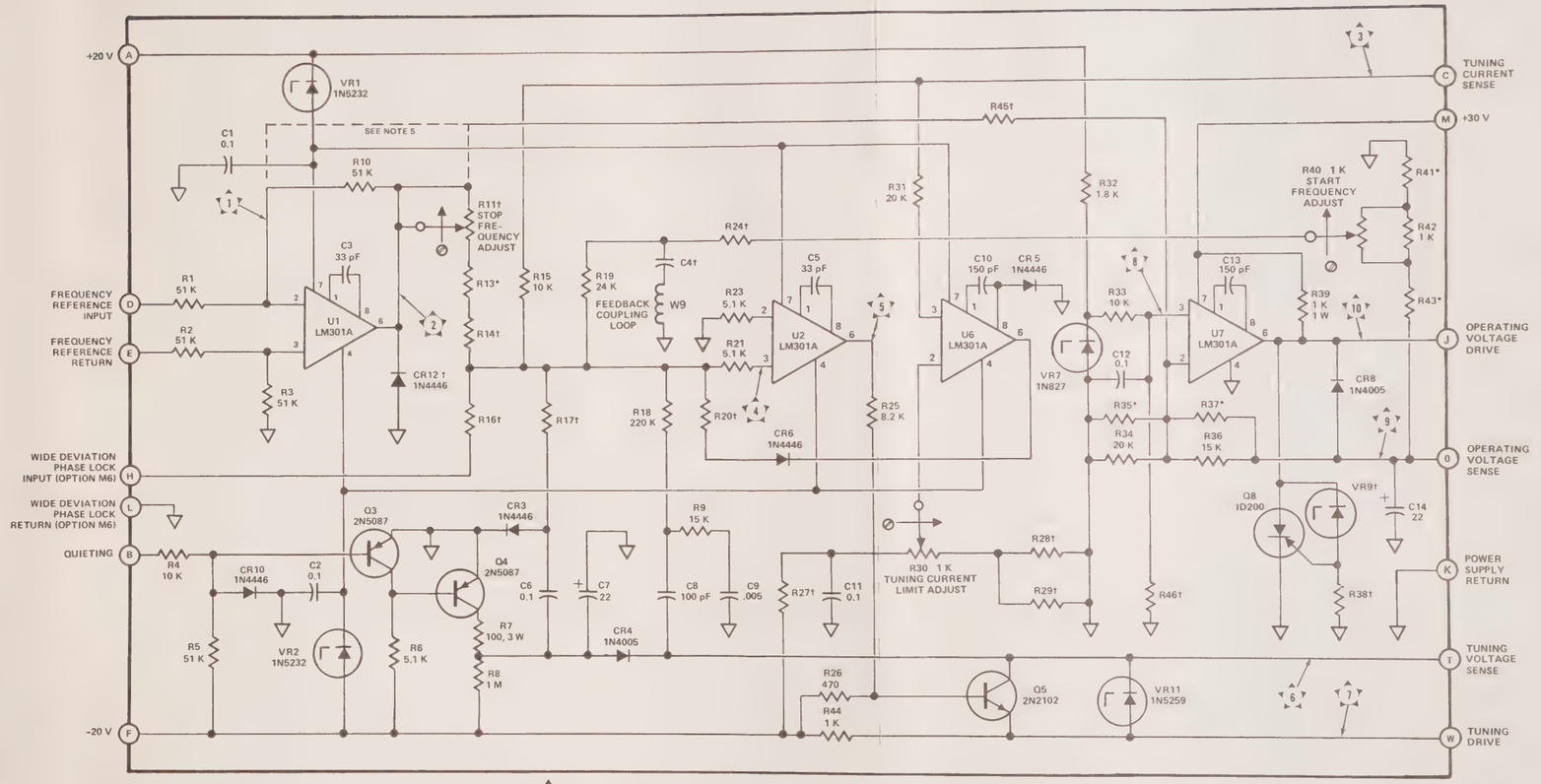
FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
8-3	A1	B			01220	BOARD ASSY — OSCILLATOR DRIVER Consisting of:
	A1C1		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C2		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C3		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C4	B				CAPACITOR
	A1C5		100175	DM15ED330J0	72136	CAPACITOR, Mica, 33 pF ±5%, 500 V
	A1C6		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C7		104135	T392D226K025AS	31433	CAPACITOR, Tantalum, 22 μF ±10%, 25 V
	A1C8		100173	DM15FD101J0	72136	CAPACITOR, Mica, 100 pF ±5%, 500 V
	A1C9		107293	TG-D-50	56289	CAPACITOR, Ceramic, .005 μF ±20%, 100 V
	A1C10		100220	DM15FD151J0	72136	CAPACITOR, Mica, 150 pF ±5%, 500 V
	A1C11		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C12		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C13		100219	DM15FD151J0	72136	CAPACITOR, Mica, 150 pF ±5%, 500 V
	A1C14		104135	T392D226K025AS	31433	CAPACITOR, Tantalum, 22 μF ±10%, 25 V
	A1CR1					Not used
	A1CR2					Not used
	A1CR3		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A1CR4		105531	1N4005	04713	DIODE, Silicon, 1 A
	A1CR5		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A1CR6		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A1CR7					Not used
	A1CR8		105531	1N4005	04713	DIODE, Silicon, 1 A
	A1CR9					Not used
	A1CR10		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A1CR11					Not used
	A1CR12	B				DIODE
	A1Q1					Not used
	A1Q2					Not used
	A1Q3		105673	2N5087	04713	TRANSISTOR, PNP Silicon, TO-92
	A1Q4		105673	2N5087	04713	TRANSISTOR, PNP Silicon, TO-92
	A1Q5		105652	2N2102	04713	TRANSISTOR, NPN Silicon, TO-5
	A1Q6					Not used
	A1Q7					Not used
	A1Q8		105660	ID200	12969	RECTIFIER, Silicon-Controlled, TO-5
	A1R1		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A1R2		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A1R3		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A1R4		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A1R5		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A1R6		104854	RL07S512G	24546	RESISTOR, Metal Film, 5100 Ω ±2%, 1/4 W
	A1R7		105416	RW69V101	01686	RESISTOR, Wirewound, 100 Ω ±5%, 3 W
	A1R8		104972	RC07GF105K	01121	RESISTOR, Carbon, 1 MΩ ±10%, 1/4 W
	A1R9		104865	RL07S153G	24546	RESISTOR, Metal Film, 15 kΩ ±2%, 1/4 W
	A1R10		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A1R11	B				RESISTOR, Variable (Stop Frequency Adjust)
	A1R12					Not used
	A1R13	T				RESISTOR, Value Selected at Test
	A1R14	B				RESISTOR
	A1R15		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A1R16	B				RESISTOR
	A1R17	B				RESISTOR
	A1R18		104963	RC07GF224K	01221	RESISTOR, Carbon, 220 kΩ ±10%, 1/4 W
	A1R19		104870	RL07S243G	24546	RESISTOR, Metal Film, 24 kΩ ±2%, 1/4 W
	A1R20	B				RESISTOR
	A1R21		104854	RL07S512G	24546	RESISTOR, Metal Film, 5100 Ω ±2%, 1/4 W
	A1R22					Not used
	A1R23		104854	RL07S512G	24546	RESISTOR, Metal Film, 5100 Ω ±2%, 1/4 W
	A1R24	B				RESISTOR
	A1R25		104859	RL07S822G	24546	RESISTOR, Metal Film, 8200 Ω ±2%, 1/4 W
	A1R26		104829	RL07S471G	24546	RESISTOR, Metal Film, 470 Ω ±2%, 1/4 W
	A1R27	B				RESISTOR
	A1R28	B				RESISTOR
	A1R29	B				RESISTOR
	A1R30		105490	3305P-1-102	80294	RESISTOR, Variable, 1000 Ω (Tuning Current Limit Adjust)
	A1R31		104868	RL07S203G	24546	RESISTOR, Metal Film, 20 kΩ ±2%, 1/4 W
	A1R32		104843	RL07S182G	24546	RESISTOR, Metal Film, 1800 Ω ±2%, 1/4 W

Table 8-2. Oscillator Driver Assembly A1 Replaceable Parts List (Continued)

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
	A1R33		104681	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A1R34		104868	RL07S203G	24546	RESISTOR, Metal Film, 20 kΩ ±2%, 1/4 W
	A1R35	T				RESISTOR, Value Selected at Test
	A1R36		104868	RL07S203G	24546	RESISTOR, Metal Film, 20 kΩ ±2%, 1/4 W
	A1R37	T				RESISTOR, Value Selected at Test
	A1R38	B				RESISTOR
	A1R39		105006	RC32GF102K	01121	RESISTOR, Carbon, 1000 Ω ±10%, 1 W
	A1R40		105490	3305P-1-102	80294	RESISTOR, Variable, 1000 Ω (Start Frequency Adjust)
	A1R41	T				RESISTOR, Value Selected at Test
	A1R42		104837	RL07S102G	24546	RESISTOR, Metal Film, 1000 Ω ±2%, 1/4 W
	A1R43	T				RESISTOR, Value Selected at Test
	A1R44		104837	RL07S102G	24546	RESISTOR, Metal Film, 1000 Ω ±2%, 1/4 W
	A1R45	B				RESISTOR
	A1R46	B				RESISTOR
	A1U1		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A1U2		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A1U3					Not used
	A1U4					Not used
	A1U5					Not used
	A1U6		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A1U7		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A1VR1		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A1VR2		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A1VR3					Not used
	A1VR4					Not used
	A1VR5					Not used
	A1VR6					Not used
	A1VR7		100386	1N827	99942	DIODE, Reference, 6.2 V ±.001%/°C
	A1VR8					Not used
	A1VR9	B				DIODE, Zener
	A1VR10					Not used
	A1VR11		105597	1N5259	04713	DIODE, Zener, 39 V ±10%, 1/2 W
			105619	BHS-5-TO5	71002	PAD, Transistor
			936219		01220	BOARD, Printed Circuit

VIEWS FROM TOP OF SEMICONDUCTOR DEVICE





NOTES:

1. SYMBOL * INDICATES COMPONENT VALUE SELECTED AT TEST.
2. SYMBOL † INDICATES COMPONENT VALUE OR PRESENCE DETERMINED BY RF PLUG-IN MODEL; REFER TO TABLE 8-2.
3. SYMBOL ⬠ INDICATES REFERENCE TEST POINT. REFER TO SECTION IV FOR PHYSICAL LOCATION.
4. POTENTIOMETER ARROWS INDICATE CW ROTATION.
5. CONNECT R45 TO U1-2/R10 JUNCTION FOR POSITIVE PROGRAMMING SLOPE.

Figure 8-3. Oscillator Driver A1 Parts Location/Schematic Diagram

SECTION IX

LEVELER/AMPLITUDE MODULATOR

9-1. GENERAL

This section contains circuit theory, trouble isolation information, a replaceable parts list, and a schematic diagram with parts location and test point information for Leveler/Amplitude Modulator Printed Circuit Board Assembly A2 and Power Meter Leveling Printed Circuit Board Assembly A3. Overall plug-in and microwave component operating theory for the RF plug-in in which A2 is installed may be found in Section VI, with the plug-in chassis interconnect wiring diagram and parts list in Section VII.

9-2. THEORY OF OPERATION

The output amplitude of the RF plug-in is controlled by modulator AT1; the general operating principles of this device were described in Section VI. Drive for AT1 is provided by A2.

The Leveler circuits integrate several inputs into drive for AT1:

1. Output power control from front-panel **RF LEVEL** potentiometer R5
2. 1-kHz square-wave modulation from the generator on A2
3. External amplitude modulation signals coupled through the mainframe
4. Sweep retrace blanking from the mainframe
5. Leveling feedback from an external crystal detector
6. Leveling feedback from an RF power meter (Options M7 and M7A)

The output drive to the modulator is determined by the total current from all input sources flowing into the summing junction of operational amplifier A2U4. If the RF plug-in is equipped with Option M3 or M3A (Fast AM), the amplitude control signal is coupled directly to modulator AT1, bypassing all circuitry on A2.

9-2.1 Drive Levels

A modulator drive input of 20 to 50 milliamperes (refer to Table 1-1) will turn the shunt PIN diodes completely on to fully attenuate the signal from the oscillator. A zero drive level to the PIN diodes allows the RF input to pass with minimum attenuation of about two decibels. The voltage output at A2-S ranges from about 1.2 volts negative for minimum attenuation to about six volts positive for maximum attenuation.

9-2.2 Operating Modes

Two operating modes are available in most RF plug-ins with YIG-tuned oscillators: leveling off and external leveling. Some plug-ins may be fitted with an internal directional detector (option M2). Such units have a three-position front panel **LEVELER** switch with three modes: leveling off, external leveling and internal leveling. A (generally undesired) fourth mode can occur if the leveling feedback

loop is broken, usually by a cable defect or operator selection of the external leveling mode when no external leveling devices are connected. In this mode there is no control of the output amplitude; it will be either fully on or fully off.

Units equipped with Option M3 or Option M3A cannot be operated in a leveled mode and a fast AM mode simultaneously.

Units equipped with Option M7 or Option M7A are leveled with the "recorder" output of a microwave power meter through the amplifier circuits of A2.

9.2.2.1 LEVELING OFF MODE. The simplest amplitude control configuration exists when the **LEVELER** switch is set to **OFF**. The amplitude control circuits are in an open loop configuration in leveling off mode; if there are no marker, blanking, or external AM inputs, and if the **1 KHZ** switch is set to **OFF**, then the only inputs to the summing junction of A2U4 come from **RF LEVEL** control R5 through A2R4 and from terminal J of A2 through R3 and A2R3.

In the unleveled mode, offset current flows from the minus 20 volt supply through A2R16, R3, and A2R3 to provide a negative bias. Current also flows from the plus 20 volt supply through A2R15 and **RF LEVEL** control R5. A current determined by the potentiometer setting is fed to the summing junction through A2R4.

9-2.2.2 FAULT MODE. It was previously mentioned that an undefined leveling mode could occur if the **LEVELER** switch was set to **EXT** and no negative feedback input was connected. An examination of this mode demonstrates the action of the modulator driver circuits.

Setting switch S11 to **EXT** short circuits the off-level offset voltage from terminal A2-J directly to ground. With only a positive input from R5 through A2-H connected to the summing junction, A2U4 acts less as a current integrator than as a comparator. When the voltage at the inverting summing junction of A2U4 exceeds that at the non-inverting summing junction, the output changes state. The positive input causes a stiff negative output from A2U4 to drive the base of transistor A2Q5. This turns off the NPN transistor. Modulator drive comes from the minus 20 volt supply through voltage divider A2R35/A2R36.

The negative voltage input drives modulator AT1 to its minimum attenuation, allowing the maximum available oscillator output to be coupled to the **RF OUT** connector. Negative voltage at this junction also turns on switch A2CR13 and places a feedback capacitor (A2C8) across the modulator drive amplifier to eliminate spurious oscillation.

The negative output amplitude is limited to minus 1.2 volts by diode CR10 and Zener diode VR8 (acting as a conventional diode) in series across the modulator drive amplifier. In addition to the modulator protection afforded by the excursion limiter, which holds the maximum output to plus 6.2 or minus 1.2 volts, voltage limiter diodes A2CR11 and A2CR12 prevent the summing junction voltage from exceeding plus or minus 600 millivolts.

9-2.2.3 EXTERNAL LEVELING MODE. If a negative leveling feedback signal is connected to J7, it will be coupled through the closed contacts of switch S11A and through terminal A2-D to the summing junction. Resistor R3 serves as a load for the input signal in external leveling mode.

In leveled mode, switch section S11C completes a path to ground for resistors A2R13 and A2R14, which then become part of a voltage divider with A2R15. This reduces the maximum voltage available at R5 to a lower value than in unleveled mode.

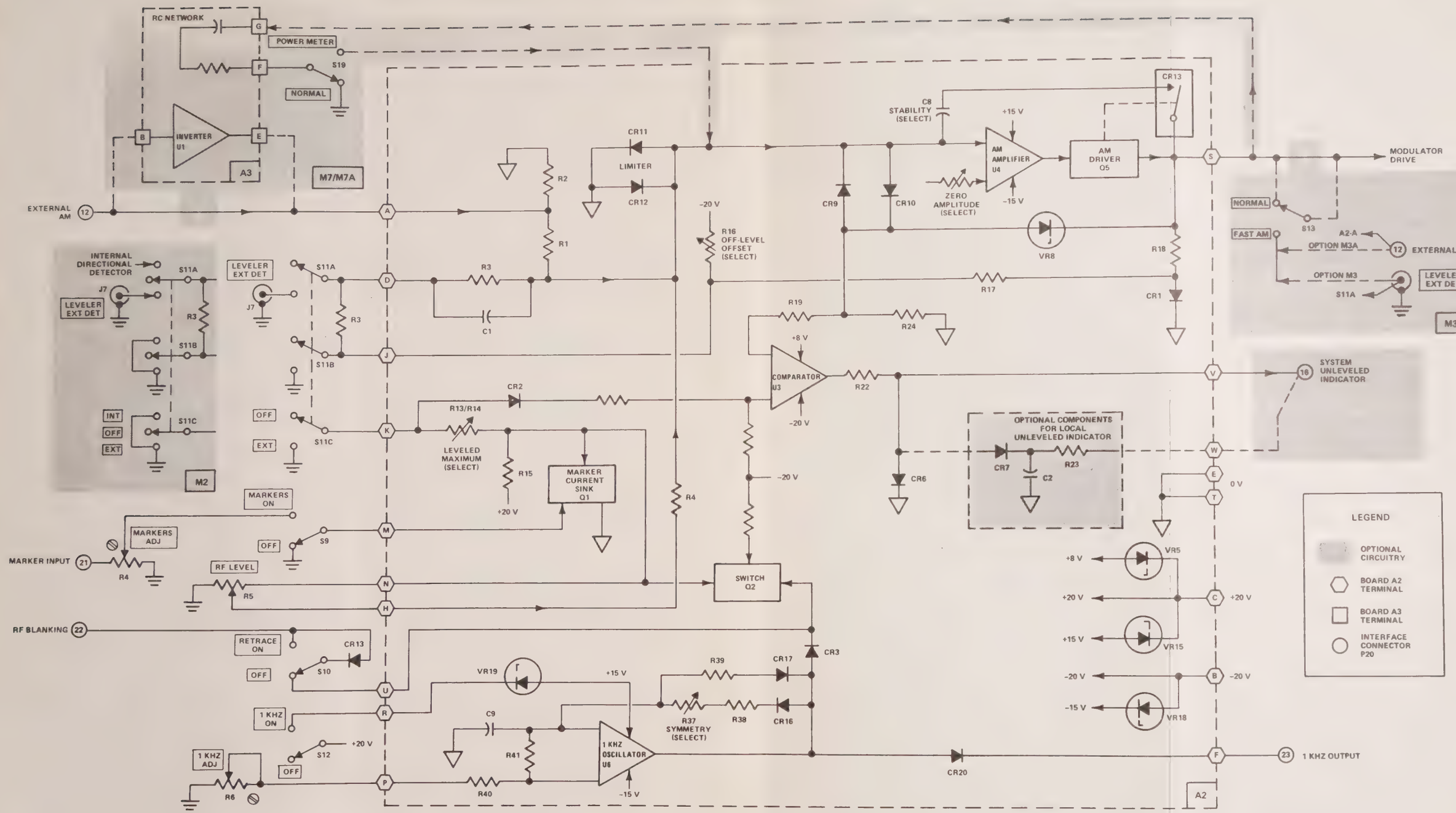


Figure 9-1. Amplitude Modulator Simplified Schematic Diagram

The inputs to the summing junction of A2U4 now consist of negative feedback through A2-D and positive **RF LEVEL** control from R5. The negative input will tend to make the output of A2Q5 positive, reducing the RF amplitude, while the positive input from R5 will tend to reduce the output of A2Q5 and increase the output amplitude. The ultimate drive level to modulator AT1 is a combination of the feedback from the external detector and the **RF LEVEL** control setting.

9-2.2.4 MARKERS. When the **MARKERS** switch is set to **ON**, a marker pulse from the mainframe is coupled through switch S9 and terminal A2-M to current sink A2Q1, reducing the current available to R5. This causes a brief reduction of the current from R5 (through A2R4) into the summing junction and reduces the RF output amplitude at marker points. The amount of reduction is determined by the marker pulse amplitude as set by **MARKERS ADJ** control R4.

9-2.2.5 BLANKING. A plus 5 volt sweep retrace (flyback) blanking pulse is coupled through diode CR13 and switch S10 to terminal A2-U when the **RETRACE** switch is set to **OFF**. During the retrace period, switch A2Q2 is turned on, causing the voltage at A2-N to become negative; the resulting current flow through R5 and A2R4 causes the summing junction of A2U4 to become negative, the output of A2U4 to become positive, and the output of A2Q5 to become positive enough to drive the PIN diodes in modulator AT1 to maximum attenuation.

The blanking input is coupled through CR13 to isolate it from the 1 kilohertz square wave which is also coupled to the base of A2Q2 through A2CR3 (refer to Paragraph 9-2.2.7).

9-2.2.6 EXTERNAL AM. External AM inputs are connected through terminal A2-A and voltage divider A2R1/A2R2 to the summing junction. As with any input to the summing junction, a negative input will reduce RF output amplitude and a positive input will increase it.

9-2.2.7 1 KHZ GENERATOR. Operational amplifier A2U6 is configured as a voltage comparator to generate a 1 kilohertz square wave. When **1 KHZ** switch S12 is set to **ON**, power is applied to A2U6 through VR19. Assuming the initial output state of A2U6 to be negative, capacitor A2C9 is charged through diode A2CR17 and resistor A2R39. As A2C9 charges, the inverting summing junction will reach a voltage level equal to that at the non-inverting junction, and the output of A2U6 will change output state. A2C9 will begin to charge (in the opposite direction) through A2CR16 and A2R37/A2R38.

When A2U6 changes output state, the polarity at the non-inverting summing junction also changes. When the charge on A2C9 reaches this new level, the output will change state again. This action takes place at the rate of one kilohertz; R6 is part of a voltage divider which allows the comparison voltage at the non-inverting summing junction to be controlled over a narrow range. By altering the level to which A2C9 must be charged in order to effect a change in the output state of A2U6, R6 functions as a frequency control.

9-2.2.8 UNLEVELED INDICATOR. RF plug-ins used in multiband sweep systems are required to provide a remote indication when they are operated in an unleveled mode. Comparator A2U3 changes its output state from about minus eighteen to plus seven volts when there is a difference between the leveling feedback input and a sample of the modulator drive output at A2VR8/A2R24.

When the **LEVELER** switch is set to **OFF**, switch section S11C opens the ground path for A2R13/A2R14 and causes current from the plus 20 volt supply to flow through A2CR2 to A2U3 and drive its output to plus seven volts.

Components A2CR7, A2C2, and A2R23 are not used in current production versions of the RF plug-in.

9-2.2.9 OPTION M7. RF plug-ins equipped with Option M7 power meter leveling are equipped with an R-C network to reduce the frequency response of the amplifier formed by A2U4 and A2Q5. The components which comprise the network are mounted on printed circuit assembly A3. The network is switched into the circuit by **POWER METER/NORMAL** switch S19.

9-2.2.10 OPTION M7A. In addition to the R-C network described in Paragraph 9-2.2.9, printed circuit assembly A3 in RF plug-ins with Option M7A include an operational amplifier configured as a unity-gain inverter. Amplifier A3IC1 inverts the external AM input from a positive-output power meter and offsets it to act as an amplitude-control signal to the external AM input of A2.

9-3. TROUBLE ISOLATION

Figure 9-2 is an aid to trouble isolation in the leveler/amplitude modulator components. This table should be used with the supporting information listed below:

1. The circuit descriptions and simplified schematic diagram in Paragraph 9-2 of this section.

2. Schematic diagram and parts location drawings Figures 9-3 and 9-4 at the end of this section; these drawings include basing diagrams of the multi-lead semiconductor devices used on A2 and A3.

Begin trouble isolation procedures with Figure 5-2 of Section V before attempting trouble isolation to the component level on A2 or A3.

9-4. REPLACEABLE PARTS LIST

Table 9-2 in this section contains a list of replaceable parts for Leveler/Amplitude Modulator Assembly A2. Tables 9-3 and 9-4 lists replaceable parts for Power Meter Leveling Assembly A3. Replaceable parts lists for the chassis assembly are found in Section VII. A replaceable parts list for Oscillator Driver Subassembly A1 is found in Section VIII.

9-4.1 Ordering Replacement Parts

The majority of the electronic parts used in construction of the A2 and A3 board assemblies are standard distributor items, and should be available locally. To order special replacement parts and parts which are not otherwise obtainable, write to Systron-Donner Corporation at the address shown at the front of this manual, or contact your local Scientific Devices office.

Be sure to include the model number and serial number of the unit for which parts are required. Please order by Systron-Donner part number; also include the A2 or A3 reference designator where applicable.

9-4.2 Explanation of Columns

9-4.2.1 FIG. NO. This column references the figure number of the drawings in which the part can be located.

9-4.2.2 REF. DESIG. Electronic parts are listed in sequence by reference designation and may be located on the schematic diagram by this designator.

9-4.2.3 **USE CODE.** An entry in this column indicates that the part may not be found in all units because it is part of an option, a part replaced when an option is ordered, or an alternate part. The component size or electrical value of a component coded "T" is chosen by test as part of a calibration procedure.

9-4.2.4 **SYSTRON-DONNER PART NUMBER.** All standard parts manufactured by Systron-Donner or manufactured to Systron-Donner specifications are listed in this column, but not in the *MFR'S PART NUMBER* column. All other purchased parts which have been assigned Systron-Donner part numbers are also listed in this column. These part numbers must be used when ordering parts.

9-4.2.5 **MFR'S PART NUMBER.** Commercially-available parts not manufactured by Systron-Donner or to Systron-Donner specifications are listed in this column. Insofar as possible, these part numbers are complete. For best results, always include a complete part description as well as the listed manufacturer's part number when ordering replacement parts from manufacturers or distributors.

9-4.2.6 **MFR. CODE.** The five-digit Federal Manufacturers Codes, as listed in Cataloging Handbooks H4-1 and H4-2, are listed in this column. These codes and corresponding manufacturers are listed in Table 9-1.

9-4.2.7 **DESCRIPTION.** Descriptions of component parts of subassemblies are indented to indicate the parts comprising each subassembly.

9-5. SCHEMATIC DIAGRAMS

Figure 9-3 is the A2 board parts location drawing and schematic diagram. Figure 9-4 contains the schematic diagrams and parts location drawings for both versions of the A3 board. The schematic diagram for the A1 board is found in Section VIII; the chassis wiring diagram is in Section VII.

Table 9-1. Manufacturer's Codes

CODE	NAME
01121	Allen Bradley Co., Milwaukee, WI 53204
01220	Systron-Donner Corporation, Microwave Division, Van Nuys, CA 91411
03508	General Electric Co., Semiconductor Products Dept., Auburn, NY 13021
04713	Motorola, Inc., Semiconductor Products Division, Phoenix, AZ 85036
18714	RCA Solid State Products Division, Findley, OH 45840
24546	Corning Glass Works, Bradford, PA 16701
27014	National Semiconductor Corporation, Santa Clara, CA 95051
31433	Union Carbide Corp., Materials Systems Div., Components Dept., Greenville, SC 29606
56289	Sprague Electric Co., North Adams, MA 01247
63743	Ward Leonard Electric Co., Inc., Subsidiary of Unimax Group, Inc., Mount Vernon, NY 10550
71002	Birnbach Co., Inc., Freeport, LI, NY 11520
72136	Electro-Motive Manufacturing Co., Inc., Subsidiary of International Electronics Corp., Willamantic, CT 06226
91418	Radio Materials Co., Division of P.R. Mallory, Chicago, IL 60646

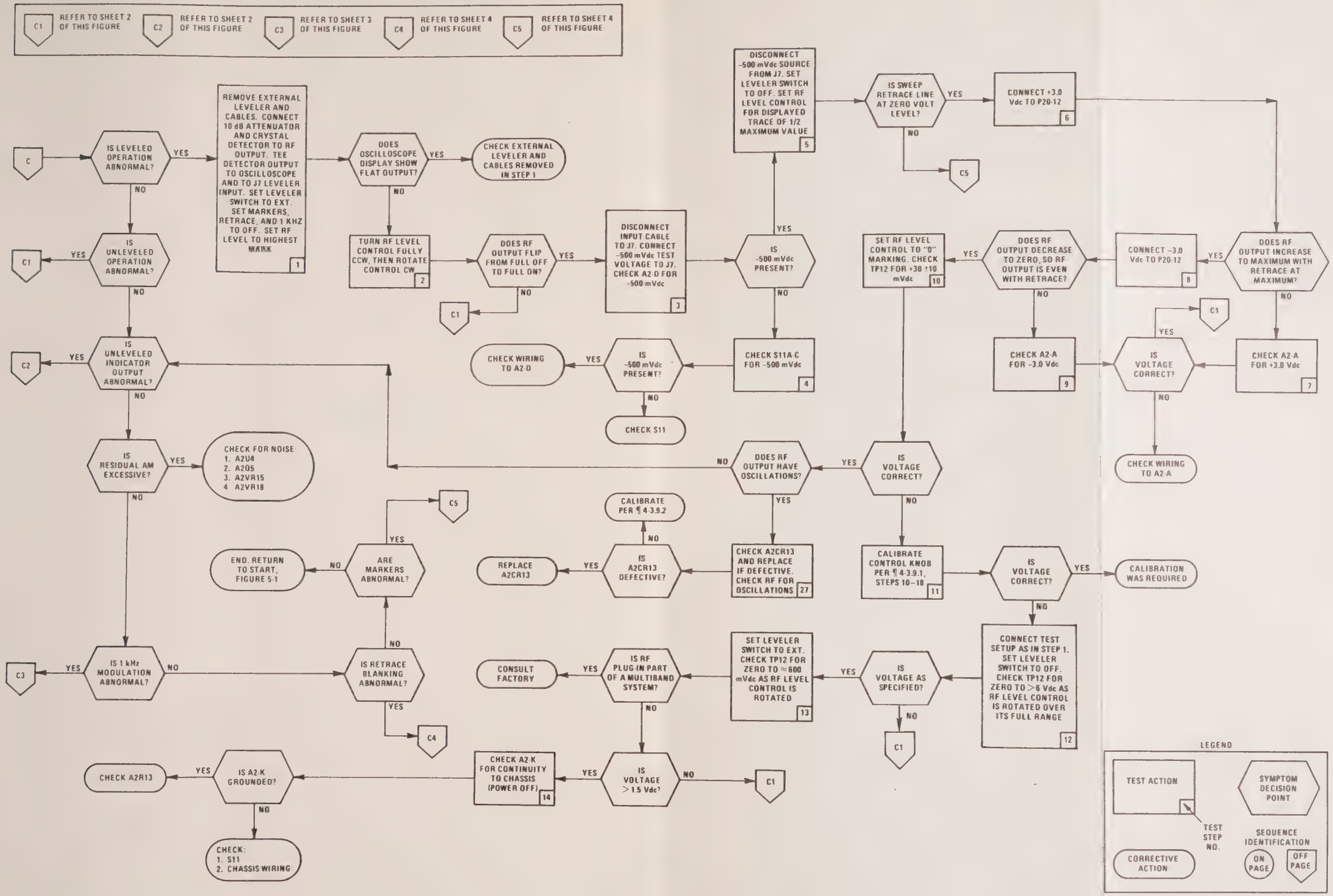

C1 REFER TO SHEET 2 OF THIS FIGURE
C2 REFER TO SHEET 2 OF THIS FIGURE
C3 REFER TO SHEET 3 OF THIS FIGURE
C4 REFER TO SHEET 4 OF THIS FIGURE
C5 REFER TO SHEET 4 OF THIS FIGURE
C
IS LEVELED OPERATION ABNORMAL?
YES
NO
REMOVE EXTERNAL LEVELER AND CABLES. CONNECT 10 dB ATTENUATOR AND CRYSTAL DETECTOR TO RF OUTPUT. TEE DETECTOR OUTPUT TO OSCILLOSCOPE AND TO J7 LEVELER INPUT. SET LEVELER SWITCH TO EXT. SET MARKERS, RETRACE, AND 1 KHZ TO OFF. SET RF LEVEL TO HIGHEST MARK
1
DOES OSCILLOSCOPE DISPLAY SHOW FLAT OUTPUT?
CHECK EXTERNAL LEVELER AND CABLES REMOVED IN STEP 1
TURN RF LEVEL CONTROL FULLY CCW, THEN ROTATE CONTROL CW
2
DOES RF OUTPUT FLIP FROM FULL OFF TO FULL ON?
C1
DISCONNECT INPUT CABLE TO J7. CONNECT -500 mVdc TEST VOLTAGE TO J7. CHECK A2-D FOR -500 mVdc
3
DISCONNECT -500 mVdc SOURCE FROM J7. SET LEVELER SWITCH TO OFF. SET RF LEVEL CONTROL FOR DISPLAYED TRACE OF 1/2 MAXIMUM VALUE
5
IS SWEEP RETRACE LINE AT ZERO VOLT LEVEL?
CONNECT +3.0 Vdc TO P20-12
6
IS -500 mVdc PRESENT?
CHECK S11A-C FOR -500 mVdc
4
CHECK WIRING TO A2-D
IS -500 mVdc PRESENT?
CHECK S11
IS UNLEVELED OPERATION ABNORMAL?
IS UNLEVELED INDICATOR OUTPUT ABNORMAL?
IS RESIDUAL AM EXCESSIVE?
CHECK FOR NOISE:
1. A2U4
2. A2Q5
3. A2VR15
4. A2VR18
SET RF LEVEL CONTROL TO "0" MARKING. CHECK TP12 FOR +30 ±10 mVdc
10
DOES RF OUTPUT DECREASE TO ZERO, SO RF OUTPUT IS EVEN WITH RETRACE?
CONNECT -3.0 Vdc TO P20-12
8
DOES RF OUTPUT INCREASE TO MAXIMUM WITH RETRACE AT MAXIMUM?
CHECK A2-A FOR -3.0 Vdc
9
IS VOLTAGE CORRECT?
CHECK A2-A FOR +3.0 Vdc
7
CHECK WIRING TO A2-A
DOES RF OUTPUT HAVE OSCILLATIONS?
IS VOLTAGE CORRECT?
CALIBRATE PER ¶ 4-3.9.2
CHECK A2CR13 AND REPLACE IF DEFECTIVE. CHECK RF FOR OSCILLATIONS
27
CALIBRATE CONTROL KNOB PER ¶ 4-3.9.1, STEPS 10–18
11
IS VOLTAGE CORRECT?
CALIBRATION WAS REQUIRED
REPLACE A2CR13
IS A2CR13 DEFECTIVE?
C5
END. RETURN TO START, FIGURE 5-1
ARE MARKERS ABNORMAL?
IS 1 kHz MODULATION ABNORMAL?
C3
IS RETRACE BLANKING ABNORMAL?
C4
CONNECT TEST SETUP AS IN STEP 1. SET LEVELER SWITCH TO OFF. CHECK TP12 FOR ZERO TO >6 Vdc AS RF LEVEL CONTROL IS ROTATED OVER ITS FULL RANGE
12
IS VOLTAGE AS SPECIFIED?
C1
SET LEVELER SWITCH TO EXT. CHECK TP12 FOR ZERO TO ≈600 mVdc AS RF LEVEL CONTROL IS ROTATED
13
CONSULT FACTORY
IS RF PLUG-IN PART OF A MULTIBAND SYSTEM?
CHECK A2-K FOR CONTINUITY TO CHASSIS (POWER OFF)
14
IS VOLTAGE >1.5 Vdc?
C1
CHECK A2R13
IS A2-K GROUNDED?
CHECK:
1. S11
2. CHASSIS WIRING
LEGEND
TEST ACTION
TEST STEP NO.
SYMPTOM DECISION POINT
SEQUENCE IDENTIFICATION
ON PAGE
OFF PAGE
CORRECTIVE ACTION

Figure 9-2. Leveler/Amplitude Modulator A2 Troubleshooting Diagram (Sheet 1)

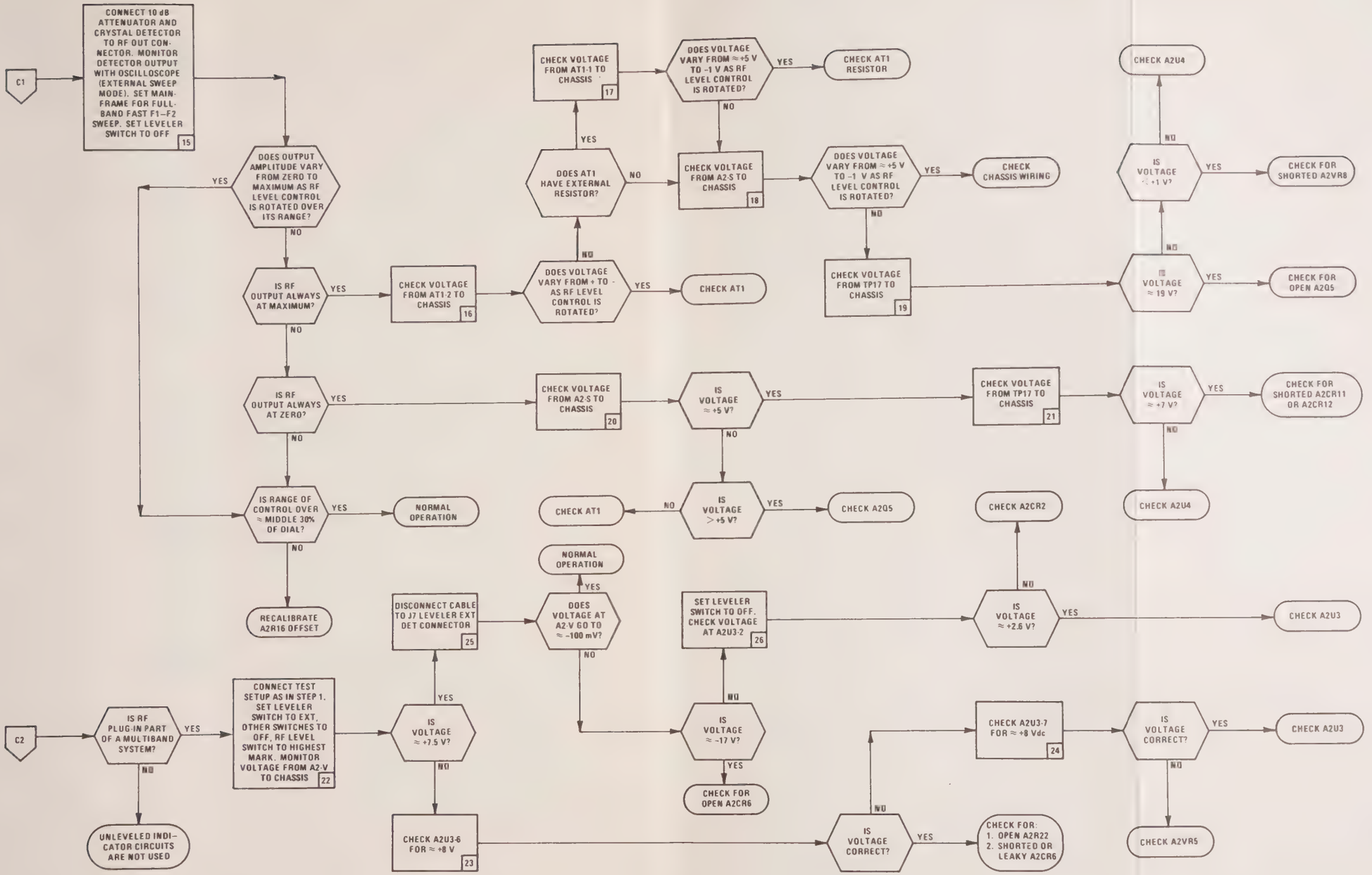

C1
CONNECT 10 dB ATTENUATOR AND CRYSTAL DETECTOR TO RF OUT CONNECTOR. MONITOR DETECTOR OUTPUT WITH OSCILLOSCOPE (EXTERNAL SWEEP MODE). SET MAINFRAME FOR FULL-BAND FAST F1–F2 SWEEP. SET LEVELER SWITCH TO OFF 15
DOES OUTPUT AMPLITUDE VARY FROM ZERO TO MAXIMUM AS RF LEVEL CONTROL IS ROTATED OVER ITS RANGE?
YES
NO
IS RF OUTPUT ALWAYS AT MAXIMUM?
YES
NO
CHECK VOLTAGE FROM AT1-2 TO CHASSIS 16
DOES VOLTAGE VARY FROM + TO - AS RF LEVEL CONTROL IS ROTATED?
YES
NO
CHECK AT1
CHECK VOLTAGE FROM AT1-1 TO CHASSIS 17
DOES VOLTAGE VARY FROM ≈ +5 V TO –1 V AS RF LEVEL CONTROL IS ROTATED?
YES
NO
CHECK AT1 RESISTOR
DOES AT1 HAVE EXTERNAL RESISTOR?
YES
NO
CHECK VOLTAGE FROM A2-S TO CHASSIS 18
DOES VOLTAGE VARY FROM ≈ +5 V TO –1 V AS RF LEVEL CONTROL IS ROTATED?
YES
NO
CHECK CHASSIS WIRING
CHECK VOLTAGE FROM TP17 TO CHASSIS 19
CHECK A2U4
IS VOLTAGE < +1 V?
YES
NO
CHECK FOR SHORTED A2VR8
IS VOLTAGE ≈ 19 V?
YES
NO
CHECK FOR OPEN A2Q5
IS RF OUTPUT ALWAYS AT ZERO?
YES
NO
CHECK VOLTAGE FROM A2-S TO CHASSIS 20
IS VOLTAGE ≈ +5 V?
YES
NO
CHECK VOLTAGE FROM TP17 TO CHASSIS 21
IS VOLTAGE ≈ +7 V?
YES
NO
CHECK FOR SHORTED A2CR11 OR A2CR12
IS RANGE OF CONTROL OVER ≈ MIDDLE 30% OF DIAL?
YES
NO
NORMAL OPERATION
RECALIBRATE A2R16 OFFSET
CHECK AT1
IS VOLTAGE > +5 V?
NO
YES
CHECK A2Q5
CHECK A2CR2
CHECK A2U4
NORMAL OPERATION
YES
DISCONNECT CABLE TO J7 LEVELER EXT DET CONNECTOR 25
DOES VOLTAGE AT A2-V GO TO ≈ –100 mV?
NO
SET LEVELER SWITCH TO OFF. CHECK VOLTAGE AT A2U3-2 26
IS VOLTAGE ≈ +2.6 V?
YES
NO
CHECK A2U3
C2
IS RF PLUG-IN PART OF A MULTIBAND SYSTEM?
YES
NO
UNLEVELED INDICATOR CIRCUITS ARE NOT USED
CONNECT TEST SETUP AS IN STEP 1. SET LEVELER SWITCH TO EXT, OTHER SWITCHES TO OFF, RF LEVEL SWITCH TO HIGHEST MARK. MONITOR VOLTAGE FROM A2-V TO CHASSIS 22
IS VOLTAGE ≈ +7.5 V?
YES
NO
CHECK A2U3-6 FOR ≈ +8 V 23
IS VOLTAGE ≈ –17 V?
YES
NO
CHECK FOR OPEN A2CR6
IS VOLTAGE CORRECT?
YES
NO
CHECK FOR: 1. OPEN A2R22 2. SHORTED OR LEAKY A2CR6
CHECK A2U3-7 FOR ≈ +8 Vdc 24
IS VOLTAGE CORRECT?
YES
NO
CHECK A2U3
CHECK A2VR5

Figure 9-2. Leveler/Amplitude Modulator A2 Troubleshooting Diagram (Sheet 2)

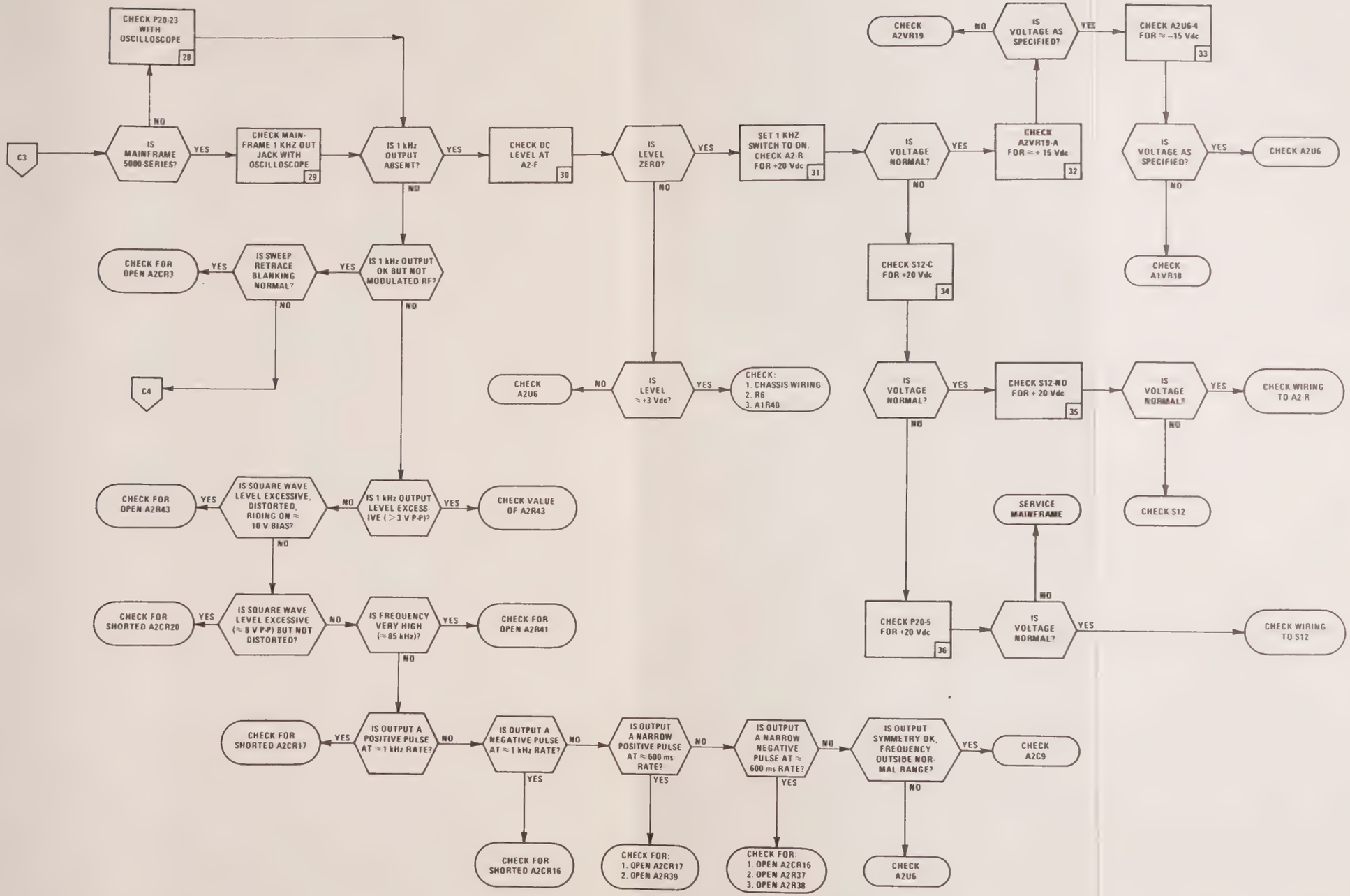


Figure 9-2. Leveler/Amplitude Modulator A2 Troubleshooting Diagram (Sheet 3)

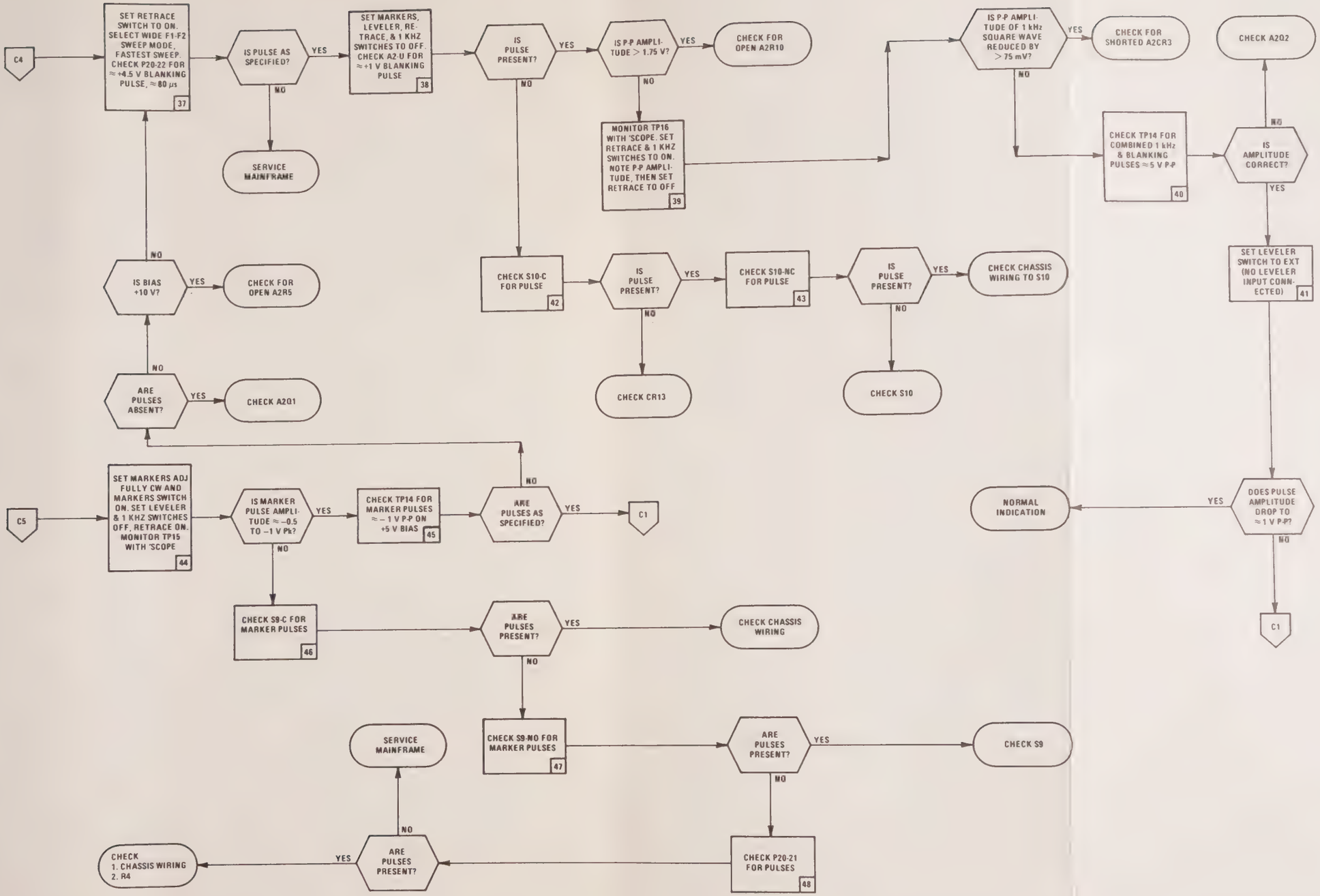


Figure 9-2. Leveler/Amplitude Modulator A2 Troubleshooting Diagram (Sheet 4)

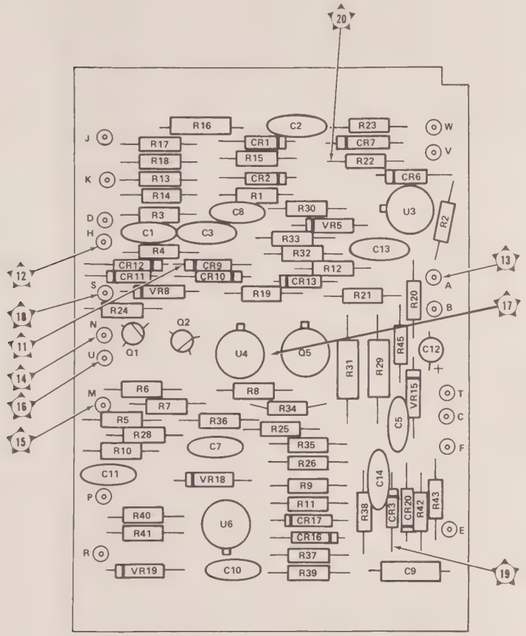
Table 9-2. Leveler/Amplitude Modulator Assembly A2 Replaceable Parts List

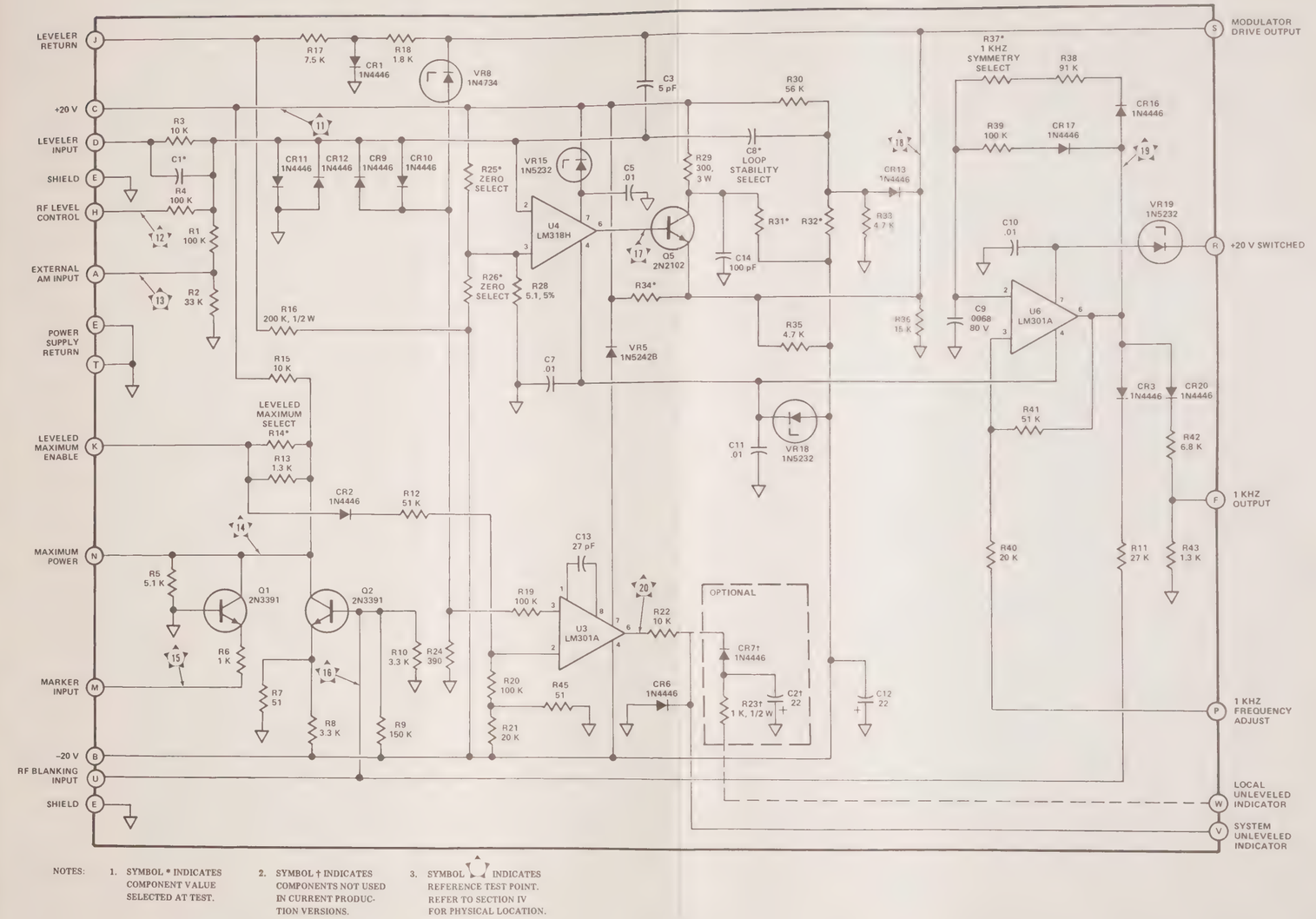
FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
	A2		950384		01220	BOARD ASSY – LEVELER/A.M. Consisting of:
	A2C1	T				CAPACITOR, Value Selected at Test
	A2C2		104135	T392D226K025AS	31433	CAPACITOR, Tantalum, 22 μF, 25 V
	A2C3		104136	DM15050K	72136	CAPACITOR, Mica, 5 pF ±5%, 500 V
	A2C4					Not used
	A2C5		100103	TA110	91418	CAPACITOR, Ceramic, 0.01 μF +80, –20%, 100 V
	A2C6					Not used
	A2C7		100103	TA110	91418	CAPACITOR, Ceramic, 0.01 μF +80, –20%, 100 V
	A2C8		100179	DM15ED560J0	72136	CAPACITOR, Mica, 56 pF ±5%, 500 V
	A2C9		100192	192P68292	56289	CAPACITOR, Mylar, 6800 pF ±10%, 80 V
	A2C10		100103	TA110	91418	CAPACITOR, Ceramic, 0.01 μF +80, –20%, 100 V
	A2C11		100103	TA110	91418	CAPACITOR, Ceramic, 0.01 μF +80, –20%, 100 V
	A2C12		104135	T392D226K025AS	31433	CAPACITOR, Tantalum, 22 μF, 25 V
	A2C13		102545	DM15ED270J0	72136	CAPACITOR, Mica, 27 pF ±5%, 500 V
	A2C14		100173	DM15FD101J0	72136	CAPACITOR, Mica, 100 pF ±5%, 500 V
	A2CR1		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR2		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR3		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR4					Not used
	A2CR5					Not used
	A2CR6		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR7		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR8					Not used
	A2CR9		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR10		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR11		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR12		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR13		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR14					Not used
	A2CR15					Not used
	A2CR16		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR17		105532	1N4446	03508	DIODE, Silicon. 75 PIV
	A2CR18					Not used
	A2CR19					Not used
	A2CR20		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2Q1		105654	2N3391	03508	TRANSISTOR, NPN Silicon, R-67
	A2Q2		105654	2N3391	03508	TRANSISTOR, NPN Silicon, R-67
	A2Q3					Not used
	A2Q4					Not used
	A2Q5		105652	2N2102	04713	TRANSISTOR, NPN Silicon, TO-5
	A2R1		104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W
	A2R2		104873	RL07S333G	24546	RESISTOR, Metal Film, 33 kΩ ±2%, 1/4 W
	A2R3		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A2R4		104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W
	A2R5		104854	RL07S512G	24546	RESISTOR, Metal Film, 5100 Ω ±2%, 1/4 W
	A2R6		104837	RL07S102G	24546	RESISTOR, Metal Film, 1000 Ω ±2%, 1/4 W
	A2R7		104806	RL07S510G	24546	RESISTOR, Metal Film, 51 Ω ±2%, 1/4 W
	A2R8		104849	RL07S332G	24546	RESISTOR, Metal Film, 3300 Ω ±2%, 1/4 W
	A2R9		104889	RL07S154G	24546	RESISTOR, Metal Film, 150 kΩ ±2%, 1/4 W
	A2R10		104849	RL07S332G	24546	RESISTOR, Metal Film, 3300 Ω ±2%, 1/4 W
	A2R11		104871	RL07S273G	24546	RESISTOR, Metal Film, 27 kΩ ±2%, 1/4 W
	A2R12		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A2R13		104840	RL07S132G	24546	RESISTOR, Metal Film, 1300 Ω ±2%, 1/4 W
	A2R14	T				RESISTOR, Value Selected at Test
	A2R15		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A2R16		104905	RL20S204G	24546	RESISTOR, Metal Film, 200 kΩ ±2%, 1/2 W
	A2R17		104858	RL07S752G	24546	RESISTOR, Metal Film, 7500 Ω ±2%, 1/4 W
	A2R18		104843	RL07S182G	24546	RESISTOR, Metal Film, 1800 Ω ±2%, 1/4 W
	A2R19		104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W
	A2R20		104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W
	A2R21		104868	RL07S203G	24546	RESISTOR, Metal Film, 20 kΩ ±2%, 1/4 W
	A2R22		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A2R23		104901	RL20S102G	24546	RESISTOR, Metal Film, 1000 Ω ±2%, 1/2 W
	A2R24		104827	RL07S391G	24546	RESISTOR, Metal Film, 390 Ω ±2%, 1/4 W
	A2R25	T				RESISTOR, Value Selected at Test
	A2R26	T				RESISTOR, Value Selected at Test
	A2R27					Not used
	A2R28		104923	RC07GF5R1J	01121	RESISTOR, Carbon, 5.1 Ω ±5%, 1/4 W

Table 9-2. Leveler/Amplitude Modulator Assembly A2 Replaceable Parts List (Continued)

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
	A2R29		105421	3X300	63743	RESISTOR, Wirewound, 300 Ω ±5%, 3 W
	A2R30		104879	RL07S563G	24546	RESISTOR, Metal Film, 56 kΩ ±2%, 1/4 W
	A2R31	T				RESISTOR, Value Selected at Test
	A2R32	T				RESISTOR, Value Selected at Test
	A2R33		104853	RL07S472G	24546	RESISTOR, Metal Film, 4700 Ω ±2%, 1/4 W
	A2R34	T				RESISTOR, Value Selected at Test
	A2R35		104853	RL07S472G	24546	RESISTOR, Metal Film, 4700 Ω ±2%, 1/4 W
	A2R36		104865	RL07S153G	24546	RESISTOR, Metal Film, 15 kΩ ±2%, 1/4 W
	A2R37	T				RESISTOR, Value Selected at Test
	A2R38		104884	RL07S913G	24546	RESISTOR, Metal Film, 91 kΩ ±2%, 1/4 W
	A2R39		104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W
	A2R40		104868	RL07S203G	24546	RESISTOR, Metal Film, 20 kΩ ±2%, 1/4 W
	A2R41		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A2R42		104857	RL07S682G	24546	RESISTOR, Metal Film, 6800 Ω ±2%, 1/4 W
	A2R43		104840	RL07S132G	24546	RESISTOR, Metal Film, 1300 kΩ ±2%, 1/4 W
	A2R44					Not used
	A2R45		104806	RL07S510G	24546	RESISTOR, Metal Film, 51 Ω ±2%, 1/4 W
	A2U1					Not used
	A2U2					Not used
	A2U3		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A2U4		105609	LM318H	27014	INTEGRATED CIRCUIT, Operational Amplifier
	A2U5					Not used
	A2U6		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A2VR1					Not used
	A2VR2					Not used
	A2VR3					Not used
	A2VR4					Not used
	A2VR5		105578	1N5242B	04713	DIODE, Zener, 12 V ±5%, 1/2 W
	A2VR6					Not used
	A2VR7					Not used
	A2VR8		100421	1N4734A	04713	DIODE, Zener, 5.6 V ±10%, 1 W
	A2VR9					Not used
	A2VR10					Not used
	A2VR11					Not used
	A2VR12					Not used
	A2VR13					Not used
	A2VR14					Not used
	A2VR15		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A2VR16					Not used
	A2VR17					Not used
	A2VR18		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A2VR19		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
			105619	BHS-5-TO5	71002	PAD, Transistor
			936190		01220	BOARD, Printed Circuit

VIEWS FROM TOP OF SEMICONDUCTOR DEVICE





NOTES:
1. SYMBOL * INDICATES COMPONENT VALUE SELECTED AT TEST.
2. SYMBOL † INDICATES COMPONENTS NOT USED IN CURRENT PRODUCTION VERSIONS.
3. SYMBOL ⟨1⟩ INDICATES REFERENCE TEST POINT. REFER TO SECTION IV FOR PHYSICAL LOCATION.

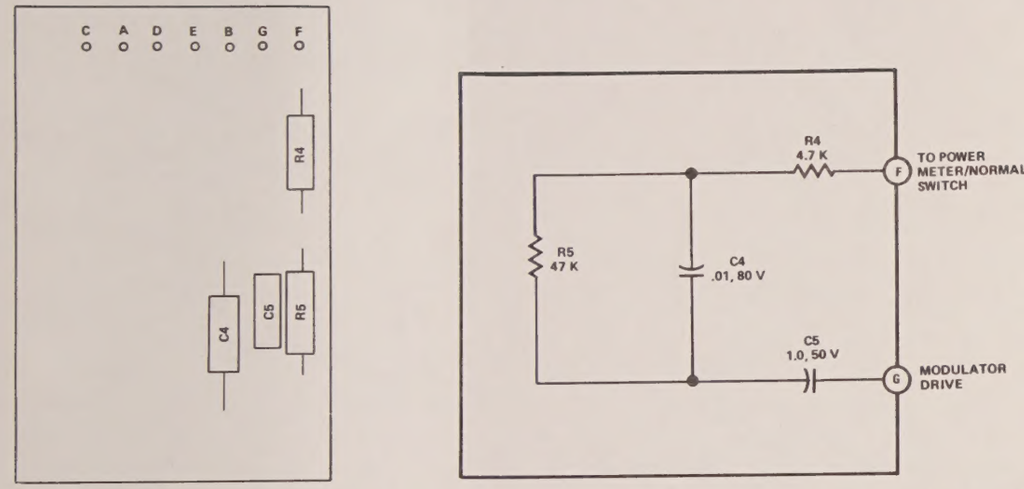
Figure 9-3. Leveler/Amplitude Modulator A2 Parts Location/Schematic Diagram

Table 9-3. Power Meter Leveling Assembly A3 (Option M7)

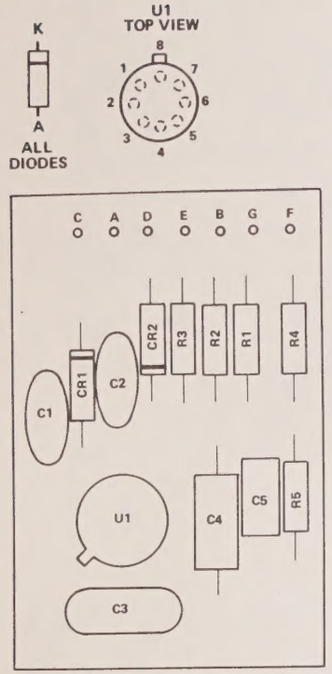
FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
9-4	A3	M7	95060501		01220	BOARD ASSY — POWER METER LEVELING Consisting of:
	A3C1					Not used
	A3C2					Not used
	A3C3					Not used
	A3C4		104147	192P1039R8	56389	CAPACITOR, Mylar, 0.01 μF ±10%, 80 V
	A3C5		107627	3420-050E105M	00656	CAPACITOR, Ceramic, 1.0 μF ±20%, 50 V
	A3R1					Not used
	A3R2					Not used
	A3R3					Not used
	A3R4		104853	RL07S472G	24546	RESISTOR, Metal Film, 4700 Ω ±2%, 1/4 W
	A3R5		104877	RL07S473G	24546	RESISTOR, Metal Film, 47 kΩ ±2%, 1/4 W
			936276		01220	BOARD, Printed Circuit

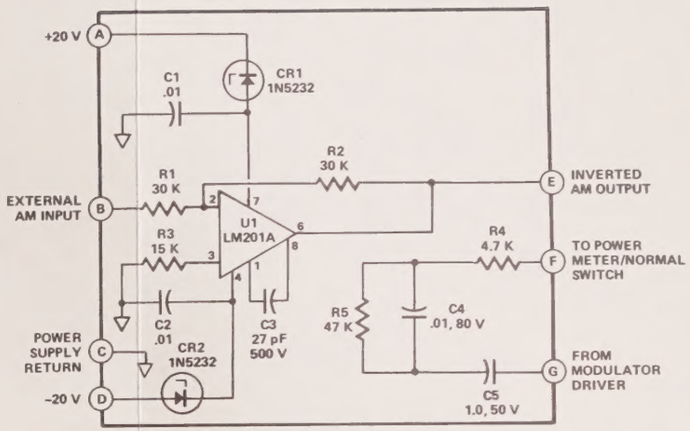
Table 9-4. Power Meter Leveling Assembly A3 (Option M7A)

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
9-4	A3	M7A	95060502		01220	BOARD ASSY — POWER METER LEVELING Consisting of:
	A3C1		150100	TGS10	56280	CAPACITOR, Ceramic, 0.01 μF +80% −20%, 100 V
	A3C2		150100	TGS10	56280	CAPACITOR, Ceramic, 0.01 μF +80% −20%, 100 V
	A3C3		102545	DM15ED270J0	72136	CAPACITOR, Mica, 27 pF ±5%, 500 V
	A3C4		104147	192P1039R8	56389	CAPACITOR, Mylar, 0.01 μF ±10%, 80 V
	A3C5		107627	3420-050E105M	00656	CAPACITOR, Ceramic, 1.0 μF ±20%, 50 V
	A3CR1		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A3CR2		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A3R1		104872	RL07S303G	24546	RESISTOR, Metal Film, 30 kΩ ±2%, 1/4 W
	A3R2		104872	RL07S303G	24546	RESISTOR, Metal Film, 30 kΩ ±2%, 1/4 W
	A3R3		104865	RL07S153G	24546	RESISTOR, Metal Film, 15 kΩ ±2%, 1/4 W
	A3R4		104853	RL07S472G	24546	RESISTOR, Metal Film, 4700 Ω ±2%, 1/4 W
	A3R5		104877	RL07S473G	24546	RESISTOR, Metal Film, 47 kΩ ±2%, 1/4 W
	A3U1		105616	LM201AH	04713	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
			936276		01220	BOARD, Printed Circuit



A3 OPTION M7 NEGATIVE POWER METER LEVELING ASSEMBLY 95060501





A3 OPTION M7A POSITIVE POWER METER LEVELING ASSEMBLY 95060502

Figure 9-4. Power Meter Leveler A3 Parts Location/Schematic Diagram

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